

INGSA CASE STUDY COMPENDIUM 2007-2020 - CAPACITY BUILDING CONTENT

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International Network for Government Science Advice

CASE STUDY COMPENDIUM

2017 – 2020 TRAINING MATERIAL CONTENT DEVELOPMENT



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The International Network for Government Science Advice

INGSA Capacity Building

One of INGSA's core activities is to assist with the development or strengthening of advisory systems through capacity building. Case Studies provide an engaging and dynamic way of exploring and interrogating the complexities that exist at the science/policy/society interfaces.

INGSA has invested heavily in creating case studies across a range of engagement styles and thematic topics – and these are utilised in our own workshops as well as released under Creative Commons for anyone else to use in their training.

INGSA is constantly developing a range of case study options. These broadly fall into a range of styles:

- [Fictional cases](#) – These use imaginary scenarios to illuminate some of the complexity of the issues faced at the science/policy nexus. They provide thorny problems for which there is no right answer – exposing participants to the risks and trade-offs inherent in complex policy making and evidence brokerage.
- [Sufficiency of Evidence Cases](#) – These prioritise the question of how decision-making changes as the evidence at hand changes. These are excellent at underscoring the pressures faced by policy-makers in making decisions on limited information, and the issues facing evidence-producers to offer advice that is timely, appropriate and aware of its own limitations.
- [Historic cases](#) – These dissect real world issues and aim to providing a deeper understanding of issues that people might already be aware of.

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We are continually building our case study library and welcome your ideas and support in developing new cases. Please send your submissions or enquiries to info@ingsa.org



Contents

Fictional Case Studies 4

- ABRON: Future Marine Resources in Post-Oil Economy
- AFRISTAN: Health, Nutrition and Public Policy
- ALTERRA: Air Quality and Energy
- AMPLESIA: Childhood Obesity - Science, Economy and Local Knowledge
- CARBONERIA: Competing technology-based economic proposals
- CORALESIA: Balancing Biodiversity Sustainability & Indigenous Interests
- DOUMBELANE: Mobilization of water & land resources for food security
- REPUBLIC OF ESTRELA: Internal Displacement, Climate Change and Planning
- FREUDANIA: Youth Mental Health
- GONSWANA: Food insecurity and new technologies
- ILEOJOGBON: Legislating Homosexuality
- INNOVANDIA: Smart city networks and AI for solving societal problems
- ISLANDIA: Island variation - Childhood obesity
- JIBAJI: Construction of a dam and governance of water resources
- KASSEMBLÉ: Integrating traditional techniques - unemployment and poverty
- MIDGAZE: Armed rebellion and reintegration of ex-combatants
- MULIKAMEE: Fighting unemployment, emigration and radicalization
- NICOTERIA: E-cigarettes as a public health strategy
- NJAGALA: Youth and Social Media
- ORANGERIA: Mobilising Social Science Expertise to Reduce Crime
- PANDERIA: Pandemics, panics and international borders
- PULPINEA: A potential trade-off between biodiversity & the economy
- RAWHITIA: Healing Psychological Trauma after Civil War through Education
- RESOURCIA: Powering Change - Immigration, Labour and Social Cohesion
- RHODECAR: Creating employment through waste management
- SWAMPERIA: Future technology in the fight against malaria
- TANGERIA: Gene-Editing and Climate Response
- TERREMOTIA: Folk Knowledge and the Understanding of Risk
- UNITED MICROBIAN STATES: Antimicrobial resistance

Sufficiency of Evidence Case Studies..... 157

- OSTAL: Waste, Land Use and Technological Development
- PANDERIA: When Pandemic turns to panic
- VASCOVY – Emergency Response – Risk and uncertainty in a digital age

Historic Case Studies 178

- DUESBERG, MBEKI AND AZT: Contentious science meets contentious politics
- FUKUSHIMA - regulation, planning, and communication in emergencies
- GLYPHOSATE: Health, Economic and Public Concerns about GM
- THE IPCC: Transferable Model or Cautionary Tale?
- SHALE GAS: shale gas extraction in Canada



FICTIONAL CASE STUDIES

The International Network for Government Science Advice

INGSA CASE STUDIES

ABRON: FUTURE MARINE RESOURCES IN POST-OIL ECONOMY

Tatjana Buklijas (INGSA/University of Auckland)



ABRON:

FUTURE MARINE RESOURCES IN POST-OIL ECONOMY

Background and context

Abron is a country with the population of 4 million. Much of Abron is covered by a large sandy desert. With less than 10% of the land used for agriculture (mostly pastures on the southern and eastern slopes of the central mountain range), the country had been historically sparsely populated by nomadic tribes of camel herders. Most of the population today lives along the coastline in particular in and around the capital and the largest urban centre, the historic port of Babra. Traditionally, the economy had relied on trade and export of limited agricultural goods (dates, camels, cattle and fish) but the discovery of petroleum reserves in the early twentieth century has dramatically increased the national income, and transformed the country. The past governments had exploited this resource aggressively and the reserves have been depleted while extensive exploration has not discovered new sources. The recent fall in oil price, along with the potential for declining production, are hurting the economy. Abron's GDP per capita, once one of the highest in the world, has started to decline. As yet, the sluggish economy has not disturbed the political consensus. The ruling party, linked to the hereditary ruler's family, has been in power since democracy was established two decades ago. Yet in the last election growing concerns over the future economic direction boosted the opposition, which made real gains.

While Abron has benefited in past decades from the global reliance on petroleum, it is increasingly at high risk of particularly harsh effects of climate change. The already high average temperature is likely to increase further, desert areas are expanding, and the rising sea levels may inundate the coastal urban and agricultural areas. The historical main water source, the Abron/Afristan aquifer, which is shared with Abron's larger neighbour, Afristan, has been severely depleted by over-extraction. Water has become a source of tension between the two countries. The already scarce land suitable for agriculture is likely to reduce further. Increasingly concerned with food security, the government of Abron is encouraging the development of agriculture fit for the current and predicted climate conditions. However, access to water is a major obstacle. Not only are water tables dropping, but also the salinity of existing water sources is increasing. The country runs a number of desalination plants but their operation is getting more expensive as the brine is pumped back into the sea. With a long coastline, fishing, largely controlled by several rich tribal families, has traditionally been a core part of Abron's economy. It remains important, although fishing stocks have to be managed carefully and there are fears of the impact of rising temperatures and salinity on the marine life.

Concerns about food and water security are part and parcel of broader concerns about the post-oil future for Abron. There is a broad understanding that Abron must transition to sustainable energy sources, and that it must develop an oil-independent economy. The nascent high-end tourist industry is built around diving and snorkelling in the area of little explored coral reefs. But there is some doubt about its viability following the disastrous effects on the reef tourism in Afristan by a Travel magazine article and CNN Travel documentary. These reportages pointed to the rapid loss of colour from the reefs caused by ocean warming, and also to a high-profile case of a tourist imprisoned for

inappropriate behaviour on a beach. There is already some hint of loss of colour in the Abron reef, but advocates for tourism say it still offers some of the best diving in the world. While other new branches of economy (such as shipping) are being developed, they do not secure enough income to sustain the same, or even similar, standard of living to which the Abron's population is used – and certainly not enough to support expensive and necessary infrastructure such as desalination plants.

Problem

Abron lies along the edge of the continental plate. Abron Sea was formed through the movement of the (still widening) Babra Rift. The sub-seafloor is active, with hydrothermal vents on the sea floor and temperatures of 60 °C. A string of volcanic islands, which belongs to Abron, is situated parallel to the Abron coastline some 180 kilometres to the east. Coral reefs surrounding these islands are the sites of developing tourism.

While it has been known for long time that the area around these hydrothermal vents is mineral-rich, no detailed exploration has been done. An international mining company with unique expertise in seafloor rare mineral mining has approached the government of Abron for the prospecting rights. The proposal hinges on the hypothesis that the area is rich in rare minerals used in batteries, in particular cobalt, arguably the most expensive mineral in the world. The company, Future Ocean Energy (FOE), claims that the existing data indicate that Abron sea floor may contain enough cobalt to make Abron energy-independent post-oil.

The project has attracted much attention within the government, however there is also significant opposition. The same area has been proposed for the establishment of a marine protected area, the largest in the region. It has an exceptionally diverse ecosystem with 146 species of fish not found anywhere else. Coral reefs are an important part of this ecosystem; a visiting scientist from a major marine biology centre in Europe has warned that contamination from the seabed mining will hurt those coral reefs as the ocean currents take the debris in their direction

Furthermore, in 2016, a team of archaeologists, working on one of the largest and until recently uninhabited volcanic islands (now the site of an eco-tourist diving resort), found human bones, as well as some tools, dated to around 60,000 years BC, exceptionally well preserved in the volcanic ash. The bones had been sent to the leading ancient DNA laboratory in Europe, which has established that they belonged to archaic humans possibly related to Denisovans, an extinct species (or subspecies) of the genus *Homo*, previously found in Siberia. This amazing discovery was the subject of a National Geographic documentary. The finding has the potential to dramatically alter the understanding of human evolution as the location of the island does not fit with the current maps of the spread of Denisovans. Two international teams in collaboration with the local university are now applying for funding to conduct further research on other islands of the volcanic archipelago. The Minister of Science and Culture has asked his officials to check whether the island meets the criteria for the UNESCO World Heritage site.

The Minister of Science and Culture, Minister of Tourism and Minister of Environment, with support of some other cabinet members, are arguing that mining prospecting should not be allowed in the area of such high environmental and scientific significance and sensitivity. They point out that the evidence on which Future Ocean Energies is basing its claims is weak, that the proposal does not account for the safe disposal or storage of tailings, and that Abron should first explore a variety of

sustainable energy sources that, combined, could provide a good energy cover: tidal power, high altitude wind turbines, and solar. The Minister of Agriculture and Fishing has also sided with this group. While he is cautious about the potential of these energy sources, he is under the pressure by leading fishing families and their companies in the country to oppose the seabed mining project. The fishermen are nervous about the potential impact of mining on this ecosystem in particular because of its high value as a spawning area.

Other cabinet ministers, led by the Minister of Energy and Minister of Economic Development, are arguing that the country cannot afford the luxury of rejecting the application: Abron needs to find resources that would set it up for post-oil future. Also, prospecting, they promise, will not cause significant environmental consequences.

The debate has spilled out into the public sphere. There was initially much support for the argument of the Minister of Energy, and excitement about the possibility of finding cobalt in the Abron territorial seas. However, marine biologists from the local university (who are collaborating in a large international project aimed at finding high-value molecules from marine organisms) have entered the discussion, arguing that there is a strong economic, alongside environmental and cultural/scientific, reason **not** to mine in the area. Namely, the diversity of species is based on the genetic diversity driven by the unusual conditions including high temperatures and high CO₂ concentration. These genes could in the future of a changed climate become extremely useful, for instance in the development of genetically modified agricultural organisms. But a clerical authority has warned against the development of genetically modified organisms, currently banned in Abron. An international environmental lobby group issued a press release suggesting that the finding of an archaic human species (or subspecies) right in the middle of this area may not be coincidental: it could tell us something about human adaptation to unusual environmental conditions – a view scoffed at by a leading European evolutionary biologist.

Opponents of the FOE application argue that allowing mining—even prospecting—could irreparably ruin this unique environment. Even if cobalt is found, it is not certain that the payoff will be as high as expected, because there is an international push to find a cheaper, more accessible replacement. The global ore market is notoriously volatile, a leading economist has warned, and the venture may turn out to be a loss. Media figure prominently in the debate. A local newspaper has been promoting the potential of tourism; the rights for tourist developments on the island famous for its coral reefs are owned by the editor's brother. Their youngest brother is the chief executive of the Ministry of Tourism.

Future Ocean Energy has now informed the government that it will not wait forever. Abron's neighbour, Afristan, has expressed interest in their work and expertise, and is willing to give them the prospecting licence at conditions better than those discussed by Abron. The battle over water, alongside historical and constitutional differences, means that the relationship between Afristan and Abron could be described as rather competitive; a position championed by the Foreign Minister. Although Afristan's coastline and territorial sea are smaller than Abron's, it could gain an advantage over Abron, should the mineral be found. At the same time, another newspaper has published a story about the connections between the Minister of Science and Culture and a board member of a nuclear power plant construction company based in Asia. Indeed, the Minister has spoken at an energy conference about the potential for nuclear power in small countries such as Abron, while the CEO of the company has met with government officials to discuss nuclear power.

The ruler has summoned the Prime Minister to say that the contention within the cabinet must be resolved and decisions must be made, so that the country can move on. He does not want the opposition party gaining more support simply because the governing party cannot make a sensible decision.

The prime minister feels under immense pressure and asks the newly established Science and Innovation Council which is chaired by the former Vice Chancellor of the National University of Abron, and who has acted unofficially as his science advisor, to advise him on how to proceed and address the issue.

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INGSA CASE STUDIES

AFRISTAN: HEALTH, NUTRITION AND PUBLIC POLICY

Tatjana Buklijas (INGSA/University of Auckland)



AFRISTAN:

HEALTH, NUTRITION AND PUBLIC POLICY

Background and context

Afristan is a country in the Middle East. Geographically, it is divided into three regions with distinct climates and ecosystems: coastal plains, a large mountain range in the western and central parts of the country, and desert in the east. Its historic capital Naavale is located on the central mountain plateau. Traditionally its economy relied on agriculture along the coast and in the mountains (sorghum, vegetables, fruit, more recently coffee, livestock and fishing), but the discovery of rich petroleum reserves in the east and in neighbouring landlocked countries enabled Afristan to benefit through both pipelines and refineries. These developments dramatically increased the national income, and transformed the country. It has further benefited from its reputation as a regional hub for multinational firms and a welcoming place for international businesses.

The increased wealth has led to rapid population growth. The growth has been partially fuelled through immigration, because domestic population could not provide sufficient workforce for extensive infrastructure projects and necessary service (health, hospitality). The population is also growing through natural increase, a result of the combined fall in mortality (through better medical care) and high fertility. The latter is driven by traditional social structures. While women are predominantly educated to high school level, they tend to marry young, have large families and do not participate in paid employment. The current population had grown from 1 million in 1970 to just over 4 million today, and it is predicted to grow to over 6 million by 2040. At the same time, the country leaders are aware of the need to plan for a post-oil future and possibly retracting economy. Afristan has been developing industries such as tourism, logistics and shipping. But with the challenging geography, food and water security remain pressing issues.

The rapid growth of urban centres, an urban planning culture that is centred on cars – due, largely, to low petrol prices - rather than active transport modes, and a harsh climate making outdoor activities difficult for much of the year, have all resulted in very low levels of physical activity. This is doubly true for women, who, for cultural reasons, tend to stay at home and do not engage in sports. Additionally, the arrival of fast food chains, the increased consumption of soft drink, easy availability of imported food, have all increased access to food and caloric intake.

As a result, overweight and obesity is rising rapidly in adults as well as children. The proportion of obesity (BMI>30 kg/m²) in adults is 35%, with women, at 43.5%, having far higher rates than men (29%). Of particular concern is the rapidly growing childhood overweight and obesity. According to a survey conducted by a visiting university team, about 30% of primary school age girls and 22% of the boys are obese. Heart disease and type 2 diabetes, generally appearing before the age of 50 and sometimes even in teenage years, now confront nearly every family and is increasingly becoming a burden on the national health services. 24% of pregnancies are complicated by diabetes of pregnancy (compared to 7% in much of Western Europe)

A recent report from the WHO highlights the major problem of childhood obesity and diabetes of pregnancy in Afristan – it has the highest childhood obesity prevalence in the region and one of the highest in the world. A number of initiatives are now promoted both by the government and by international organisations working with the government. Many these are focused on nutritional education in schools and on promoting physical exercise. The Minister of Health wants to ban fast food outlets from selling to children under the age of twelve, but there are objections from some families and the powerful owner of the biggest fast food chain.

At the same time, public health authorities are warning that the obesity in children cannot be targeted separately from the obesity in adults, especially women. This is not only because families—and especially mothers—shape food preferences and activities, but because of the developmental effects of maternal obesity, poor nutrition and physical inactivity on the fetus. “To reduce childhood obesity,” the director of Obesity Research Unit at the University of Afristan in Naavale, who is also a member of the WHO Commission on Obesity, wrote in an op-ed, “we must first address the root causes of obesity in women.”

Problem

At the same time, an entrepreneurial natural products company (NPC), from Tangeria, a Western country with close historical links to Afristan, has approached the government to say that it has developed a special diet drink for children that is partly made with milk, a plant extract obtained from an endemic bush, *Banksia afristanis*, that grows only in the Afristan mountain ranges and date sugar. Extracts of *Banksia afristanis* made by boiling the leaves in syrup are used in local tribal medicine and are said to ‘help children grow’. Certainly historical stunting rates in that tribal region are low.

NPC claims that giving this drink to children from the age of 3 will reduce the risk of obesity, and that one can of this drink a day is a preferred lunch replacement for maintaining healthy growth. NPC is seeking a concession from the government to build a plant to make this meal replacement product and to be exempt from taxes and import levies on the import of the other materials for its production and sale. It is anticipated that the final product will cost slightly less than the soft drinks currently available in fast food outlets and the local markets. The company is offering to provide the product at cost to schools and it intends to export it to other countries in the region and perhaps beyond. It is also hinting at moving other of its manufacturing to Afristan if the conditions are right. Last year global manufacture by NPC led to sales of US \$2 billion.

Scientists from the local university, however, have warned the government that this ‘milk’ contains large amounts of date sugar and thus has a high content of sucrose. The university’s leading nutrition researcher (who is the former graduate supervisor of the current Afristan’s Minister of Health) claims it is irresponsible to promote this product as a part of a healthy diet for children. Further, she is pointing out that any health claims for it are not based on any randomised trials and the company’s other products are largely sold as non-proven natural products. A leading Tangerian newspaper recently published an exposé about false health claims on one of its other products.

The company counters this criticism with the argument that all health claims come from the traditional knowledge, because the drink is an artisanal version of the *Banksia afristanis* extract that has been given to children for generations. A visiting European professor of paediatrics points out that any anecdotal evidence that an extract of *Banksia Afristanis* helps children grow is likely simply because it

is high in energy and thus prevented stunting, common in other regions of Afristan until 20 years ago. His statement is criticised by a prominent local doctor who is a strong proponent of bringing indigenous knowledge into Western medicine. At the same time, an international NGO that works in the bio-prospecting space is giving patenting advice to the consortia of family groups who own the land on which the *Banksia* grows.

The Tangerian ambassador to Afristan makes it clear to government members that Tangeria would be very pleased if consent was granted and a deal could be reached for distribution of the new diet product in schools. The deputy Prime Minister comes from the tribe residing in the region where the *Banksia afristanis* is grown. The family groups who grow the plant have stated that the price they will get for the raw leaves will at least double their income as it moves from simply local market sales to being a true cash crop. The tribal leaders have made it clear to the deputy Prime Minister that they expect him to make sure approval is given to approve the diet drink.

The Prime Minister is in a quandary – he knows that obesity is a major issue and is sceptical of the health claims. The Minister of Health is in agreement. He is proposing to introduce mandatory food labelling of all products including natural ingredients, such as the “diet drink”, and taxing those containing more than 10 grams of sugar in 50 mls of fluid, as a way of controlling intake of sugars and providing income to the health sector. However, it is important to maintain strong relations with Tangeria. Also, the government is very much aware of the need to diversify the industry and prepare for an oil-free future. Developing agriculture and food production is of particular interest both for economic and food security reasons.

You are the scientific advisor to the Prime Minister and Cabinet, a post that has recently been created on a trial basis. The Prime Minister seeks your advice.

What are the considerations that you have to take into account when providing this advice?

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INGSA CASE STUDIES

ALTERRA: AIR QUALITY AND ENERGY

Tatjana Buklijas (INGSA/University of Auckland)



Background and context

Alterra is a low-income, predominantly rural country (75% of population lives outside urban centres) but with a fast-growing economy, with an average increase of GDP of 6% annually. Long-term immunization campaigns and efforts to improve sanitation and good provision with drinking water have resulted in a big reduction in infectious disease rates. Infant mortality has dropped from 150 to 40 per 1000 live births over the last 15 years and maternal mortality is showing a similar trend. Poverty among the growing population is reducing, although a third of the country's population of 6 million still lives under the poverty line. The government is investing into education, with literacy rates rapidly improving (especially among girls). "We will go straight into post-industrial era" says the ambitious government, but at the same time only 50% of households are connected to the electrical network and power cuts are an everyday occurrence for those citizens who have connections to the grid.

The geography of the land-locked Alterra is a mix of hills and valleys. The prevailing wind patterns provide little breeze in the valleys where the major towns are located. Trucking using diesel fuel is the main form of transport and electricity is generated largely from coal extracted from deposits in the north-east of the country. The most significant health polluters are emissions produced by burning wood and charcoal, used for cooking and heating because of lack of other options.

These factors plus the growing population, more roads to rural areas allowing for better trucking services, improved economic standards and industrialization have resulted in a dramatic deterioration of air quality, leading to a new set of health challenges. In cities, the new middle classes are now driving cars, yet most are second-hand imports from Asia with poor emission profiles. Air pollutants are involved in acute lower respiratory infections (bronchitis, pneumonia), chronic obstructive pulmonary disease and cancer. In particular the rates of lung cancer have skyrocketed, although this may be partly due to an increase in tobacco smoking as international tobacco companies have realised that marketing in poor countries helps replace their declining consumption in western countries.

Public health authorities are warning that the provision of clean energy is now not only an economic but also a public health problem. "We haven't reduced the rates of infections only to see our people die a slow death from lung diseases" says the local oncologist, working with the WHO. A recent report in *Nature* (12 July 2018) suggests that > 20% of infant deaths in the region are a result of air pollution. In Alterran newspapers, the issues of human health, environmental pollutants, energy accessibility and economic growth have become entangled.

Problem

The government of Alterra is aware that the current energy situation is now impinging both on economic growth and human health. There is an urgent need to scale up the energy production rapidly yet with many demands on its limited budget, the solution must be cheap.

The fastest and cheapest option is to upgrade the existing thermal power stations using coal and peat. Alterra has considerable deposits of both peat and coal especially in the northeast of the country. Ministers of Regional Development and of Energy, regional leaders as well as experts in the energy sector see the upgrade of thermal power stations as preferable solution. They are aware that coal and peat-based power plants are emission-producers, yet in contrast to the current state where air pollution is uncontrolled and produced by many small emitters, they contest that their emissions can be controlled and are localized. With regard to Alterra's country emission profile and impact, they argue that the country (which contributes very little to the global emissions) should not worry too much and that it should leave the leadership in green technologies to wealthy countries that are also the biggest emission producers.

Not everyone agrees with this solution. A group of opponents, led by the Minister of Economy, Business and Innovation and supported by the growing environmental movement, point out that this is not a cheaper solution as the exact amount of peat and coal deposits are not known and the country may end up having to import resources for ultimately obsolete technology. They argue that the country would be better off focusing on solar and wind power, which could help position itself as a new regional leader in energy innovation. This is not an entirely new proposal: in rural areas off-grid, solar-panel power supply is common, but the problem of storage remains. An Asian company, ElectroFutures, has just come out on the market with a battery that promises to exceed all the existing solar energy storage solution. It is offering to sell the technology to Alterra at cost in exchange for using the country as the case-study and advertisement. While the ElectroFutures proposal has its enthusiastic supporters, the technology is entirely untested.

The Minister of Foreign Affairs is worried about the continued increase in influence of companies from Hira (the country where the ElectroFutures has its headquarters). Hira has been investing heavily in key infrastructure in Alterra for a decade and now has a network of supporters and business partners throughout the country.

Finally, the country has the potential for substantial hydropower and there are many who argue that the best solution would be investing in a major hydropower station; some of the advocates include proponents of thermal power stations, who see the upgrade of thermal power stations as the short-term solution with the investment into hydropower as a long-term goal. The largest river of Alterra, Dayao, is demarcating the border of Alterra and its neighbour Hainish, a much larger country yet with a lagging economy and ongoing ethnic conflict. Any projects would have to be conducted in partnership with Hainish. Proponents argue that a cross-border project would be welcomed by Hainish (as they have the same problem as Alterra, only on a larger scale, and need to upgrade their energy supply) and that it would split the cost. A major foreign country with interests in the region and which has taken sides in the Hainish conflict has indicated that it would offer technical and fiscal support for the dam. Critics are pointing out that the Hainish government is not stable and any agreements may not be respected in future. It is not clear how any investments would be safeguarded, should Hainish decide to withdraw from agreement.

There is also a worry that the damming of the Dayao River will have significant environmental effect and negatively impact the agriculture in the river plain (the area with the highest population density in Alterra). Local environmental activists, supported by a major international environmental charity, have also argued that damming the Dayao would harm the habitat of several wading birds and rare amphibian species. The high-end ecotourism focused on bird watching in the wetlands of the Dayao is slow- growing but its potential is strong.

The prime minister is asking her science advisory board to advise her on how to proceed.

Notes for the mentors

Stakeholders from whose perspective the problem should/may be considered:

1. Government of Alterra as a whole/PM
2. Individual Ministers (Energy; Foreign Affairs)
3. Energy sector
4. Environmental movement
5. Tourism agency
6. Foreign investors (ElectroFutures) and their Alterran business partners
7. Regional authorities, e.g. in the northeast, in the river plains, and the mayor of the capital (largest and most polluted city)

Considerations:

1. Disentangling the issue of air quality and the impact of environmental pollutants on human health from the problem of energy. Is there evidence for measures that can be done to improve the air quality in particular with regard to the reduction of pollutants that are the most harmful to human health, separately from investments into energy?
2. While the best solution for human health is one that does not pollute the air, 'clean' solutions that are not stable or too expensive may lead to the rejection of technology and sticking to old, highly polluting an inefficient one(s).
3. For energy, separating the elements of decision-making not based on scientific evidence (e.g. international relations—with Asia, or with the neighbours; financial cost of building) from those based on science; and then, secondly, different kinds of scientific evidence (impact on environment, human health) of different modes of energy production.



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INGSA CASE STUDIES

Amplexia

Addressing childhood obesity between science, economic interests and
local knowledge



Amplexia

Addressing childhood obesity between science, economic interests and local knowledge

Background and context

Amplexia is a fast-developing country in Asia; with a population of 5 million; blessed with great weather and beautiful tropical jungles and islands. Urbanization is increasing and the traditional village population shrinking, with about 70% of the population now living in the capital city. The GDP of Amplexia is USD5,900/capita and is rising quite quickly as a result of tourism growth and remittances. The major exports are coconut oil and some low-end watches assembled from imported components (this employs some 5000 Amplexian women in assembly line work, but the company is a sub-venture of a Majorian-based company and it pays very little in the way of tax). The country also receives developmental aid from several countries, but most particularly from Majoria. Majoria is the region's most populous and economically advanced country, which is home to a considerable percentage of the Amplexian migrants.

However due to rising Majorian nationalism, fewer young Amplexians are able to obtain work visas abroad. Instead, more of them are looking for work at home, largely in tourism, and to starting families; thus the population in Amplexia has been growing steadily. Many of the young adults have no marketable skill sets and unemployment is high outside the tourism sector. Crime is high too. International tourism has brought a growing consumerism, especially in the capital city, which also hosts the only international airport, and in the towns around tourist resorts. Rapid growth of urban centres, poor urban planning with limited public transport and no safe and green spaces, liberalization of car import policies, as well as rise in crime, have made people fearful of outside activities and is resulting in the reduction of physical activity.

In the past, Amplexians suffered from under- and malnutrition caused by food insecurity and parasitic infestations. A previous administration assisted by aid agencies and advised by the WHO and FAO rolled out a "10-Year Plan" to address these problems, using multi-sectoral programmes. So far, the interventions (including fertilizer subsidies, providing farmer education and support, diversification of crops) have almost eliminated famine, severe food insecurity and severe undernutrition. Micronutrient deficiencies have been significantly reduced through supplementation. The prevalence of parasite infestations has been lowered through deworming programmes with some improvement in the nutritional status of all the segments of population.

Yet the arrival of fast food chains, the increased consumption of soft drinks and a decline in traditional fish consumption, much of which is now devoted to export markets, combined with lowered physical activity, have now pushed the balance the other way. Obesity is rising rapidly in children and in adults. According to a survey conducted by a visiting university team, about 35% of children at the age of seven are obese. Heart disease and type 2 diabetes, generally appearing before the age of 50 and sometimes even in teenage years, now confront nearly every family and are overwhelming the national medical services, the latter taking up 5-8%GDP.

A recent report from the Regional Office of the WHO highlights the major problem of childhood obesity of Amplesia. A number of initiatives are now promoted both by the government and by donor countries. Most of these are focused on nutritional education in schools and on promoting physical exercise. The Minister of Health wants to ban fast food outlets from selling to children under the age of twelve and put a tax on sugar sweetened beverages, but there are objections from some families and the powerful owner of the biggest fast food chain.

At the same time, a Majorian company has approached the government to say that it has developed a special diet drink for children that is partly made with soy milk, an Amplesian local herb and molasses. The inventors of this drink, called SMARTKID, have claims that include giving SMARTKID to children from age 3 will reduce the risk of obesity, and that one can of this drink a day is a preferred lunch replacement for maintaining a healthy weight and will help them learn better. The company is seeking a concession from the government to build a plant to make this meal replacement product and to be exempt from taxes and import levies on the import of the other materials for its production and sale. It is anticipated that SMARTKID will cost slightly less than the soft drinks currently available in fast food outlets and the local markets. The company is offering to provide the product at cost to schools and it intends to export it to other countries in the region and perhaps beyond.

Scientists from the local university have recently been made aware of the company's proposal to the government of Amplesia. They are stating that this 'milk' contains large amounts of molasses and thus has a high content of sucrose. The university's leading nutrition researcher (who is the former graduate supervisor of the current Amplesian Minister of Health) claims it is irresponsible to promote this product as a healthy part of children's diets. She is pointing out that any health claims for it are not based on any randomised trials and that the label is misleading. The company counters this criticism with the argument that all health claims come from traditional knowledge, because the drink is only a modified version of a recipe that has been given to the children for generations. Furthermore, the government has learned that an international NGO, The International Indigenous Herbal Medicine Foundation (IIHMF) that works in the bio-prospecting space, is giving licensing advice to the consortia of family groups who own the herbplantations.

The Majorian ambassador to Amplesia makes it clear to government members that Majoria would be very pleased if consent was granted and a deal could be reached for distribution of the new diet product in schools. She points out that Majoria is considering building a new airport on the main city, a major highway infrastructure project and tourist hotels. The Deputy Prime Minister, who is up for re-election next year and is also the Minister for the Economy, comes from the region where the herb is grown. The family groups who grow these herbs believe that the price they will get for the raw herbs will double their income. They have made it clear to the Deputy Prime Minister that they expect him to make sure approval is given to approve the SMARTKID diet drink. However there are some urban-based environmental groups who are concerned about the negative effect of increased commercial production of the herbs will have on biodiversity.

The dilemma

The Prime Minister is in a quandary – he knows that obesity is a major issue and is sceptical of the health claims. The Minister of Health is in agreement. She is proposing to introduce mandatory food labelling of all products including natural ingredients, such as the SMARTKID diet drink, and taxing those containing more than 10 grams in 50mls of fluid of sugar, as a way of controlling intake of sugars and providing income to the health sector. But the Minister of Foreign Affairs and Deputy Minister think it is more important to maintain strong relations with Majoria and the new industry could offer valuable opportunities. And the Minister of Culture and Heritage strongly believes that the herbal product should be supported.

You are the scientific advisor to the Prime Minister and Cabinet, a post that has recently been created on a trial basis. The Prime Minister seeks your advice.

What considerations do you need to bear in mind in doing so? Note: this question is not only about making a specific recommendation but rather about the process and considerations in doing so.



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INGSA WORKSHOP MATERIALS

CARBONERIA:

Competing technology-based economic proposals with multiple stakeholders

Writing team: Kristiann Allen, Peter Gluckman and James Wilsdon



A PIECE OF BIO-CHAR



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CARBONERIA:

Competing technology-based economic proposals with multiple stakeholders

Note: materials in this case are fictional and should not be taken to represent real-life people, places or events.

Carboneria is country of 6 million people in Sub-Saharan Africa with a relatively stable but still-maturing democratic federal system of government which has managed three largely peaceful changes in government since independence, although prior to that there had been a military coup. It is an emerging economy, though it is largely still agriculturally dominated, with a per capita GDP of \$6720 (USD) in the last year. The major source of external income is eco-tourism especially to the forested north of the country and coffee and cocoa exports from plantations in the west of the country. One European agri-food company operates 4 cocoa and coffee plantation sites in western Carboneria, but the majority of agriculture in that region is subsistence and small-scale market farming. There is also a small amount of natural gas produced but it is largely used domestically.

The population is urbanising, however, with internal migration to the regional centres and especially the federal capital city rising rapidly. The urban population in particular has undergone considerable nutritional transition with 25% now considered obese by the WHO definition, and women affected disproportionately. Currently, for reasons outlined below, the federal government is considering the promotion of bio-char use for carbon sequestration in its overall approach to enhance agricultural productivity and to highlight its commitment to climate change.

Background and context

Carboneria has invested in education as a key part of its national development strategy with an established national university system including one major university campus in the capital and five smaller regional universities in each of the state capitals. It also has established a National Science and Technology Academy and there are two medical schools including one with a well-established reputation for nutrition research.

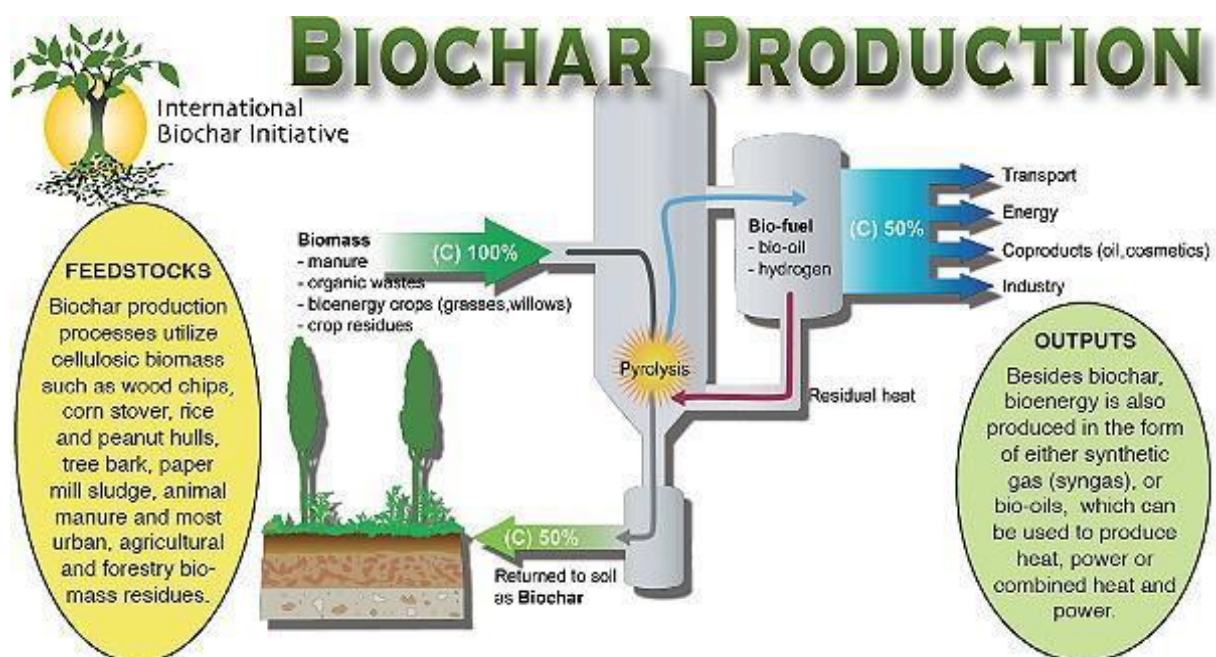
Many of the country's most respected academics have had overseas experience and have returned to Carboneria. These are mainly agricultural and environmental scientists. Their influence and the reputation of the Prime Minister internationally have strengthened the country's reputation as a global leader among developing countries seeking to address climate change. Indeed one of the IPCC working parties had been co-chaired by one of Carboneria's most distinguished scientists. Carboneria took a leading position at COP21 in Paris amongst peer countries in establishing its Intended Nationally Determined Contributions (INDCs) to climate change mitigation.

In particular, Carboneria has introduced what is seen as novel regulation of its public transport fleet (despite its limited budget an investment has been made in hybrid buses for inter-city travel) and incentive schemes for motorists and taxi drivers to maintain and/or convert to high efficiency engines using liquified gas locally produced rather than diesel in their vehicles. The government of Carboneria is also looking at policy options to support the scale up of sustainable farming techniques such as better fencing of grazing land, soil remediation and wetlands protection and better forest management practices. Overall, these policies have been hailed by urban voters, but rural communities

and especially farmers have experienced some difficulty in complying. There are local tensions between cattle herders and cropping farmers.

The dilemma

The carbon rich product known as 'bio-char' is produced by burning organic matter (e.g. farming or forestry by-product biomass) at a high temperature in an oxygen-controlled environment in a process that also produces pyrolysis (gasification). Indeed, it is similar to the process of making charcoal, which is then tilled into the soil. This technique has been used for generations by indigenous peoples in many regions of the world to enhance the agricultural productivity of soil. However, there is no credible research on the details of this practice (e.g. how long it may have taken to produce demonstrable enhanced soil properties or whether composted biomass was also added to achieve the desired effect. The impact of relative humidity in areas where this practice occurred is also an understudied factor).



BIOCHAR PRODUCTION

Since the early 2000s some scientists have suggested that, in addition to soil enrichment properties, the practice of burying bio-char can also be used as a key tool in climate change mitigation because it locks up (sequesters) carbon in soils. Consequently, there has been growing interest in using bio-char in large scale carbon sequestration projects, particularly as the global market for carbon offsets grows. The government sees this as a potential income earner.

Producing bio-char at the scale required to be meaningful in terms of greenhouse gas commitments or economic return on investment will require significant land use to create enough biomass available for pyrolysis. Much of the biomass will be obtained through the by-products of large-scale farming operations and forestry, but increasingly there is also interest in creating new plantations of fast-growing vegetation specifically for bio-char generation. The plantation solution is supported by a growing number of investors internationally who see enormous potential of bio-char in the carbon offsets market, though it has yet to be internationally recognised through the UN Framework on Climate Change.

Contrary to investor optimism, a major Australian-based NGO-funded research initiative active across Africa is very cautious about the potential for bio-char as a bio-engineering solution. There are at least 25 field trials of bio-char currently underway throughout Africa. Early results have led the scientists to acknowledge some beneficial properties of bio-char in soil enhancement, but also to state that considerably more needs to be known about the interactions between bio-char and local soils in various conditions and with various types of bio-mass, as well as its carbon draw-down and sequestration capacities in various conditions. There are no longitudinal data and the issues of scale still need to be addressed as well.

Nonetheless, a group of international investors including an American who had been a fellow student with the Carboneria Finance Minister at business school at Yale remains very encouraged by the results and want to get an early foothold in the bio-char carbon farming market. They have identified potential land for bio-char farming in the Carbonerian State of East Savaneria, which is in the rocky part of Carboneria that is largely viewed as economically unproductive because there are no commercial scale land-use operations. They deem this ideal for establishing a bio-char plantation based on growing a Eucalyptus variety that grows well in such soils and is suitable for pyrolysis and industrial scale production facility. Although the sites have no commercial farming operation, there is considerable subsistence crop farming by village cooperatives as well as some cattle and goat herding.

The investors have had preliminary talks with federal and state government officials. There has been some discussion about the impact on current land-users but officials point out that no individuals hold formal title to the land they have been husbanding for generations.

The role of scientific advice

The government and local leaders alike have also been approached by a number of strong NGOs, backed by several environmental groups internationally. But, these groups come with opposing views: About half of them want to discuss what they call the 'misconceptions surrounding bio-char production', warning that it is an unproven technology that will result in widespread displacement of local food crops and accelerated land-grabbing for low-grade biomass production because crop residues could never produce enough biomass to support a viable bio-char industry. They add that the soil enrichment properties of crop residues will also be lost if they are used for bio-char production. They raise the spectre of the bio-fuels controversy of the early 2000s, citing its *contribution* to global emissions rather than reduction. Yet other environmental groups fall on the other side of the issue; they are encouraging government officials and village leaders to take up bio-char processing as a viable economic development activity with beneficial environmental impacts despite the still uncertain potential of the market globally.

The foreign investment potential of the bio-char proposal for the same region is indeed highly attractive. A number of influential federal political leaders believe bio-char production would position the country as a leader in the growing climate mitigation market through carbon sequestration and credits trading. The proposed deal would require the state and national governments to jointly agree to lease the land to foreign developers as well as commit resources to site maintenance and infrastructure for an initial 20 year period with two 20 year rights of renewal. In return, the investors agree to a 65:25:15 split of the profits between the company, state and federal governments and to funding a local high school and agricultural technical institute in nearby villages once the company is profitable.

But most of the local village leaders see an alternative. They are being encouraged by a former nutritional scientist, turned entrepreneur, living in the capital to commercially cultivate a local shrub called flavonella as it has been found that a natural non-sugar sweetener can be extracted and commercially produced from this plant. Flavonella is endemic to East Savaneria. The sweetener, while not yet licensed by any food safety agency is being developed for likely use in diet drinks by a multinational food company (Global Health Food and Beverage Corporation GHFBC), which also has a senior scientist who is an expatriate from Carboneria working in their research headquarters. GHFBC thinks that it will be another five years before regulatory approval is achieved in a major global market for flavonella sweetener, but on the basis of their own internal data and clinical trials, it is well accepted as a replacement for sugar. The company is prepared to fund schools in the 5 villages at the centre of the proposed flavonella plantations in return for an exclusive option to purchase flavonella leaves in the event a food regulatory licence is granted for a major market in the next 7 years. An agreement has been drafted for the purchase price of flavonella leaves at that time. This agreement would guarantee significant income for the villages and the State, which is one of Carboneria's poorest.

With rumours about the new bio-char development increasing, traditional land-users have protested when potential investors visit the site and agitation is growing. There is considerable competing pressure by some local leaders and the multinational food company to start cultivating flavonella at scale.

Federal government officials are seeking advice on the merits of bio-char (including its potential to be accredited within the global Carbon Credits market) and the amount of land required for a sustainable bio-char economy to develop. But village leaders and many within the State government are not convinced about bio-char and much prefer the idea of growing flavonella, as they believe this would allow many of the state population's traditional land-use practices to continue. Thus, they want to compare the bio-char option to the continued use of the land by subsistence farmers with sustainably developing the area to cultivate flavonella. Yet for both options, the community benefit is dependent on the external market conditions materialising.

Both Federal and State governments are concerned about creating civic unrest after more than 20 years of stability. The Federal government needs to resolve the conflicting possibilities for land-use.

There is contention and strongly held views amongst different ministries.

The Science Advisor is, along with the Head of Treasury and other senior officials, expected to prepare advice for Cabinet on the path ahead. What considerations should the science advisor have in preparing their report?

PHOTO CREDITS

COVER: A piece of bio-char. Credit: K.salo.85 - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=29973096>
PAGE 3: Biochar production diagramme. Credit: Johannes Lehman via International Biochar Initiative, <http://www.biochar-international.org/technology>, CC BY-ND 3.0, <http://www.biochar-international.org/terms-of-use>. Use of image does not imply endorsement by IBI.

INGSA CASE STUDIES

Coralesia

Balancing Biodiversity Sustainability & Indigenous Population Interests



Coralesia

Balancing Biodiversity Sustainability & Indigenous Population Interests

Background and context

Coralesia is an archipelago country; consisting of 50 islands. Coralesia extends along the Equator for about 500 miles and extends 400 miles in its greatest north-south dimension. Situated between the Pacific and Indian oceans, the islands of Coralesia enclose various seas. As a result, Coralesia has developed diplomatic ties with various other countries that share these international waters. Due to the strategic location of these international waters, these diplomatic ties are continuously under threat as there remains unresolved disputed territories. Coralesia became a United Nations-recognised independent country in 1982.

Coralesia is a parliamentary democracy. The majority of the rural population of Coralesia are the indigenous population, the Sepian. While, the majority of the urban population are Temuan people that share a strong genetic lineage with the Megalion population who are the ruling class of Megalia. While evidence of Sepian settlement in Coralesia date back to more than 1000 years, the earliest evidence of Temuan settlement in Coralesia date back to 100 years; although huge wave of Temuan migration from Megalia into Coralesia occurred 100 years ago. Until independence, the Sepian language and culture was systematically suppressed by the Temuan settlers but over the last decades their position in the Coralesian society has improved. Efforts have been made to revive the Sepian language and anime religion and culture by setting up early childhood centres, schools and adult immersion courses. The Sepian traditional knowledge has become increasingly valued. In particular their oral culture, traditional ecological knowledge and indigenous practices have come to be highly appreciated by the Coralesian officials and local scientists, in the context of environmental protection.

Most of the islands of Coralesia receive rainfall from both the northeast and southwest monsoons. Another climatic element is the tropical typhoon, of which more than 20 arise each year in the southwestern Pacific (July to November) and then swing westward and northward, bringing violent winds and heavy rains to Coralesia. In 2017, a major typhoon wrecked through the Coralesia; resulting in significant damages. A large and rich neighbouring country, Megalia provided significant aid to Coralesia; including providing development low-interest loans to rebuild roads and communication infrastructure that were destroyed by the typhoon. Megalia's largest telecommunication and construction conglomerate Megatron were awarded a large share of these contracts. As a result, Coralesia was able to rebound quickly from the destruction faced from the typhoon and 2 years after the disaster, the country's communication infrastructure is better than never.

Coralesia islands' economy is very dependent on its fertile soil and rich natural resources. The population is 70% urban and 30% rural. The majority of the urban population are involved in the banking and service industry (Coralesia is a tax-haven) while the rural populace are sedentary cultivators, usually growing irrigated rice but sometimes corn (maize), yams, or cassava as their principal food crop. Other important resources include the forests, which provide valuable timber, resins, rattans, and additional gathered products. Petroleum is the chief mineral resource, exploited offshore of these islands. Manufacturing is not greatly developed. The most important industries are handicraft production and the primary processing of agricultural and mineral products for export. The majority of the urban population is highly educated; most of whom are environmentally-conscious; although much of the eco-friendly behaviour is dependent on convenience.

Coralesia's economy is also very dependent on eco-tourism. The flora and fauna of the archipelago are extremely rich and varied and reflect the strategic location of Coralesia islands as a bridge between Asia and Oceania. In fact, Coralesia derives its name from the rich coral reefs and marine life that are amongst the most biodiverse in the world. The sea occupies a major role in the Sepian culture: they see themselves as seafarers and guardians of sea creatures; as part of their animistic religious belief. However, as a result of global warming, unsustainable fishing (mostly by Temuan fishermen; the Sepian tend to fish only for their own consumption), tourism and petroleum drilling, the coral reefs and unique marine creatures are continuously under threat. Accidental introduction of alien invasive fish species have also negatively impacted a few native species.

Recently, the government of Coralesia announced the establishment of a large marine protected area some 200 kilometres off the coast of the largest island of Coralesia, Reefa where many sacred religious Sepian sites are located. The government plans to make it the third largest marine protected area in the world. No fishing or seabed development will be permitted. Nevertheless, the protected marine area will house a world-class marine research that will be primarily sponsored by Megalia. Top marine researchers around the world will be invited to conduct research and rehabilitation programmes. The Sepian community immediately objected to the plan. They fear that this is further evidence of a Megalian 'invasion' and government corruption.

The Sepian community also complain that the Coralesian government did not consult them and that it is not the Sepian but the Temuan that are the threat to the marine ecosystem. The significant loss from eco-tourism is unimaginable to many Sepian families. They argue that this another way the Temuan-led government is discriminating against them. Scientists are divided; some believe the merits of developing the protected area while some believe that collaboration with the Semuan; with their rich oral tradition about the biodiversity would be more useful. Some scientists are also concerned that the potential intellectual properties generated from the research centre will only benefit Megalia. There is great distrust regarding Megalian's interest in this endeavour.

Sepians also argue that effectively separating humans from nature breaches an important bond and does not bring about sustainability. Instead, they propose to the government to accept the traditional Sepian ways of environmental stewardship which are based on a principle of respectful human-environment interaction. The government however does not

think this strategy is appropriate for today's context, where there are far more interests involved. It points to its international commitment to protect 10% of marine space, suggesting they need to be more proactive. There are also some concerns regarding the Sepian tribal leaders, one of whom is known to have been in discussion with an international natural gas exploration company specialising in seabed natural gas reserves.

Elections are in 12 months, the Prime Minister of Coralesia is concerned that this decision is going to significantly affect the Sepian vote that will determine the outcome of the election. The Prime Minister is very keen in ensuring Coralesia's rich marine biodiversity and the good relationship with Megalia is sustained. His Cabinet proposes that they postpone decision until after the elections. However, the opposition party has taken advantage of the situation and independent of the government decision, they will risk alienating a segment of the population. Protest groups from both rural and urban communities are developing and the media is also divided; further stoking fuel into this debate. In fact, delaying the decision may be seen as a sign of incompetency and indecisiveness.

You are the scientific advisor to the Prime Minister and Cabinet, a post that has recently been created on a trial basis. The Prime Minister seeks your advice.

What considerations do you need to bear in mind in doing so? Note: this question is not only about making a specific recommendation but rather about the process and considerations in doing so.



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Republic of Doumbelane: a fictitious case study

Mobilization of water and land resources for food security

Resource persons: Dr. Madiodio Niasse and Dr. Moctar Toure, President of the Agricultural Science section of ANSTS

BRIEF STATE OF KNOWLEDGE

The emergence of the Water-Land-Energy Nexus paradigm for food security

Since 2007-2008, in the wake of soaring food and oil prices and the financial crisis, food security is at the forefront of the international development agenda. To feed the world's population, which is expected to reach 9 billion people by 2050, the FAO estimates that food production will need to be increased by 70% globally and doubled in developing countries. Achieving this objective would require a significant increase in the productivity of current arable land and a substantial increase in the amount of land used for agriculture.

However, the margin available for increasing agricultural production in the world's traditional breadbaskets—the Asian countries in particular—is disappearing: yields are already approaching their limit, while water and arable land resources are on the decline.

With climate variability and climate change, energy acts as an aggravating factor for the risk of food insecurity. The volatility of oil prices was a major factor in the record food price increase observed ten years ago: higher production costs in the agricultural sector, higher costs for the processing and transportation of food, etc. Added to this is the fact that, during the 1990s and 2000s, agricultural land dedicated to biofuels increased sharply to the detriment of that allocated to food crops. While only around 2% of global arable land is currently allocated to biofuels, land used for biofuel production (especially second-generation biofuels such as biodiesel) is projected to increase fourfold by 2030, according to the World Bank's World Development Report 2010. Energy is therefore at the heart of food security issues.

Thus we find ourselves in a situation of conflict between three of the key resources for agricultural production: water (with freshwater resources becoming increasingly scarce); land (with agricultural land that is not only shrinking, but declining in fertility); and energy (contributing to higher agricultural production costs and decreasing areas for food production). The need to recognize the multiple interactions between these resources led to the emergence of the "Nexus" paradigm, referring to a Water, Energy and Food Security Nexus (WEF) or a Water, Energy and Land Nexus (WEL). The Nexus paradigm aims to transform the vicious circle of negative interactions between water, land and energy into a virtuous circle in which the three resources are managed in an integrated and equitable manner so as to achieve sustainable food and nutrition security.

Africa, the Water-Land-Energy Nexus and food security issues

In practice, the conditions under which Nexus is applied vary greatly depending on context, the availability of water and arable land, and development levels and objectives. As this approach is relatively new, a number of definitions coexist and different analysis and evaluation models are being developed at both local and global levels. The model is already attracting interest from decision-makers seeking to establish integrated policies and insurers and investors who practice risk management.

In the search for solutions to current food issues, Africa is seen as the world region with the most assets, given the abundance of its natural resources. In particular, Africa has the world's largest land reserves, that is to say virgin, abandoned or underutilized land suitable for agricultural production. However, this apparent abundance hides enormous regional disparities on either side of the equator, the most significant discriminating factor being the availability and management of water resources. Many believe—sometimes rightly so, but often mistakenly due to oversimplification of an extremely complex reality—that there is a significant gap in agricultural productivity in Africa, and thus a significant margin for increasing agricultural production using currently cultivated land. In addition, Africa possesses an abundance of unused or underused land suitable for agriculture. According to the World Bank, of the 445 million hectares of virgin or underused arable land available around the world, almost 45% is found in Africa. For example, another World Bank study compares the African savannah to a “sleeping giant” who, once awakened—by the development of large-scale commercial agriculture—could become a gigantic agricultural production zone comparable to the Cerrado region of Brazil (Morris et al. 2009).

It is therefore not surprising to note that Africa is the main target of current large-scale land acquisitions: The World Bank (Deininger & Byerlee. 2011, op.cit.); the Land Matrix (Anseeuw et al. 2012) and the authors of various studies agree that the majority (60% to 80%) of current international land transactions (in number and in cumulative area) target acquisitions in Africa, and Sub-Saharan Africa in particular.

While Africa appears to hold one of the keys to global food security for the coming decades, it is also currently the continent that is the most vulnerable to volatile food prices and the most at risk for food insecurity.

The challenge for Africa, in a global context in which natural resources are scarce, is to mobilize and make the best use of its significant water, arable land and energy potential, in particular to ensure its food security. This will be a question of implementing policies at the State level to avoid or minimize negative interactions and optimize positive interactions within the Water-Energy-Land-Food security Nexus.

REPUBLIC OF DOUMBELANE: A FICTITIOUS CASE STUDY

Seizing investment opportunities and activating positive Nexus interactions in the Republic of Doumbelane¹

The Republic of Doumbelane is located in the mid-latitudes of Sub-Saharan Africa. In general, it is well endowed with water resources, but there are strong spatial disparities. Rainfall is abundant in the south and moderate in the centre, while the north is dry. The country is drained by a number of significant watercourses, including some of the continent's major transboundary rivers. It also has several aquifers, most of them transboundary, which are often poorly studied and underutilized. Shared governance mechanisms for these transboundary resources (especially those on the surface) have been in place for several decades, and function with some success (co-ownership of water infrastructures, integration of national regulatory frameworks, etc.). Their effectiveness, however, continues to be plagued by political, financial and technical problems. Half of the national territory of Doumbelane is in the under-exploited savannah that the World Bank compared to the Brazilian Cerrado. Nearly 60% of the population earn their living through farming, which is essentially rain-fed and thus vulnerable to the vagaries of climate. Doumbelane is heavily dependent on agricultural imports. Consumption of traditional food crops (millet, cassava, yam) is declining, while that of rice, corn and wheat is rising sharply from year to year. In 2007-2008, during the surge in imported grain prices, the populations of Doumbelane's large cities took to the streets to express their discontent, threatening the country's stability. Doumbelane is not an oil producer and is highly energy insecure.

The peasant organizations that came together at the national level condemn the passivity of the Doumbelane government in the face of the current food crisis and explain the decline in local agricultural production by the economic liberalism adopted by the Doumbelane government in the early 1980s which led to the withdrawal of the State from the productive sectors (including agriculture). With the support of national and international NGOs, Doumbelane's peasant organizations are denouncing the appropriation of their land, pointing the finger at the proliferation of land concessions granted by the State to foreign private investors.

Doumbelane has a very long tradition of agricultural and agribusiness research. Unfortunately, its institutional capacity has eroded over time, resulting in a marked decline in scientific productivity. It is still struggling to generate, appropriate and apply, in an integrated manner, the knowledge and know-how essential for understanding and addressing the issues and challenges associated with the profitable and sustainable management of natural resources. While the management of water resources (irrigation) and land resources (fertility and agronomy) is relatively well developed at the micro level, higher-level knowledge and techniques are scarce, incomplete or uncertain (long-term water resource planning, watershed management, environmental impact, etc.)

Doumbelane is an open democracy with many platforms for dialogue and exchange between government, producers, civil society, academics and researchers, but the current food crisis is creating tensions between stakeholders. It is commonly accepted that the solutions adopted to date have not been effective and that new answers, or even a new paradigm, must be considered. However, little attention has been paid to the interactions between water, arable land, energy and food security. Very few national actors have been involved in the international discussion and debate on Nexus.

¹ Doumbelane is the name of a mythical country founded by animals, the setting for most of L.S. Senghor and A. Sadji's "Leuk-le-lièvre" stories. In the Republic of Doumbelane, "the animals lived in peace" and "loved one another". "The strong protected the weak. Everybody's needs were met through the collective efforts of all". (Senghor & Sadji, *La Belle Histoire de Leuk-le-Lièvre*. EDICEF-NEA, 2001 (Reprint).

It is in this context that three large foreign investors, aware of Doumbelane's great water and arable land potential, have come to the country's capital with proposals for major agricultural investment projects.

- **Investor A** is asking for 100,000 hectares of land for biofuel production (sunflower, jatropha, oil palm) destined primarily for the European market, but some of which could be sold locally.
- **Investor B** would like to obtain 20,000 hectares of irrigable land along the country's largest river – a river that Doumbelane shares with 5 other countries. He wishes to expand his grain production area, which already extends into three of the five countries along the river.
- **Investor C**, whose financial resources exceed those of investors A and B combined, is exploring the market and is open to any agricultural investment opportunities. However, Investor C has clearly indicated to the Doumbelane authorities that he is not interested in philanthropy and is seeking to maximize return on investment.

The peasant organizations have been mobilizing for several months to denounce these investment projects, which they consider to be an aggressive large-scale appropriation of their land. They advocate support for family farming. The movement's most radical fringe is calling on the State to stop promoting conventional "star" crops—grains such as rice, corn and wheat—in favour of supporting a revival and revitalization of "orphan crops" (millet, sorghum, cowpeas, fonio, plantain, yam, cassava, etc.) to reduce the impacts of international market fluctuations on the food security of Doumbelane.

The government is working on several fronts to develop an ambitious food security strategy. It plans to team up with partners who can provide access to financial resources and expertise. It also wishes to revise its rural area management practices: land laws, appropriate land and water resource allocation mechanisms, environmental protection, decentralization, etc.

The Prime Minister of Doumbelane instructs the Minister of Agriculture to convene and chair a meeting of the High Advisory Authority on Agricultural Investment (HAAAI) of the Republic of Doumbelane. The purpose of the meeting is to examine the investment proposals and make recommendations to the government. HAAAI is a structure made up of representatives of the State, civil society, peasant organizations and the private sector. Investors A, B and C are invited, on an exceptional basis, to attend the HAAAI meeting in order to defend their projects and receive suggestions.

You are the scientific advisor to the Minister of Agriculture. You suggest to her that she should use the Nexus approach to prepare the HAAAI meeting. She receives this idea with enthusiasm, as she thinks that Nexus will change the perspectives of those present. However, she feels that there are still few examples of the application of Nexus models in other African countries.

In preparation for the HAAAI meeting, you must prepare a presentation of Nexus in order to facilitate consensus building among the participants, and advise the Minister of Agriculture on the proposals of the three investors in the context of the establishment of the food security strategy.

Republic of Doumbelane: a fictitious case study

Group exercises

PART 1: DISCUSSION

Communicating a new theoretical framework

What resources will you use to prepare your presentation? What information can you provide to convince stakeholders to adopt the theoretical framework of Nexus? What are the limitations of available knowledge and how can you communicate them in such a way as to keep your scientific credibility?

Evaluate the economic and financial options

On what criteria will you base your evaluation of the proposals? To what extent will you take into consideration the social and political environment in which the Minister of Agriculture and the Prime Minister operate? What points for negotiation will you bring to the attention of the Minister of Agriculture regarding Investors A and B? What investment opportunities will you propose for Investor C?

Co-constructing solutions

What position should you adopt during the HAAAI meeting? To what extent can you get involved? How can you encourage consensus among participants? What suggestions could you make in that regard?

PART 2: ROLE-PLAYING

You are taking part in the HAAAI meeting, and must work with the parties present to build a solution to ensure the country's food security. You hold one of the following positions:

- Advisor to Investor A or Investor B
- Scientific advisor to the Minister of Agriculture of Doumbelane
- Activist, advisor to the National Federation of Peasant Organizations and Small Family Farmers of Doumbelane
- Representative of a neighbouring country that shares a river basin with Doumbelane

You are advisor to Investor A or B: You have the floor to defend your investment project by explaining how it contributes to the food or energy security of Doumbelane while minimizing negative Nexus interactions (especially those affecting water resources) and optimizing their positive counterparts.

You are advisor to the Federation of Peasant Organizations: share your perspective on the projects, based on Nexus interactions. What investment opportunities do you see for Investor C?

You represent a neighbouring country that shares a river basin with Doumbelane: your country is concerned that the land concessions granted to private investors by Doumbelane may result in excessive water withdrawal from the river you share. You question the potential investors and the Doumbelane government on this issue. You call on all participants to consider the ways and means of avoiding the “tragedy of the commons” syndrome between countries along the river, as each country will be tempted to withdraw as much water as possible, assuming that the others are doing the same.

You are the scientific advisor to the Minister of Agriculture of Doumbelane: what merit do you see in the participants’ proposals, with regard to the government’s project to establish a food security strategy? What types of consensus do you encourage participants to explore?

You are the Minister of Agriculture of Doumbelane: you are chairing the meeting and, once it is over, you must prepare a proposal for the Prime Minister. What are your constraints and room for manoeuvre? How do you address project partners? How do you collaborate with your scientific advisor?

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INGSA CASE STUDIES

REPUBLIC OF ESTRELA: INTERNAL DISPLACEMENT, CLIMATE CHANGE AND PLANNING

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ESTRELA

INTERNAL DISPLACEMENT, CLIMATE CHANGE AND PLANNING

Context and background

Estrela is a large, low-income country that after half a century of internal conflict and political uncertainty has now seen a stable decade with the first peaceful transition of power in decades (elections 3.5 years ago) and a rapprochement with neighbours. These stable political conditions have now opened up a space for social and economic development; however the country is facing a number of challenges.

Estrela is a predominantly agricultural country with about 85% of its 80-million population living rurally. The geography of Estrela is diverse, with high mountain peaks, mountain plateaus, river valleys, coastal plains, rainforest and semiarid areas. These distinct geographic areas have been settled for generations by ethnic groups with distinct cultures and languages, and practicing different religions. While in the past clashes between ethnic groups were frequent, recent efforts to ensure equitable political representation and free cultural expression have resulted in a period of peace. However this interethnic peace is potentially fragile.

Estrela's population is growing rapidly. While infant and maternal mortality have fallen significantly, the fertility is decreasing much more slowly (at still nearly 6 children/woman), through early marriage and long reproductive span as well as limited uptake of modern birth control methods. The rapid population growth is putting a pressure on the resources of the developing country: family farms are not able to sustain such large families. This in turn is leading to young people moving to cities where they are met by high unemployment, little or no housing, and generally poor prospects. Youth emigration is on the increase but so is crime and also animosity towards migrants, seen as competitors for scarce jobs and housing. Environmental changes caused by the increased urbanization and expansion of agricultural land (both causing deforestation and pressure on water) are further complicated by the changing climate, that is wetter in some areas, drier in others (with desertification of the semiarid areas), and overall warmer and more unpredictable.

Problem

Last year a category 5 cyclone hit the coastal province of Tatinya. The initial destruction by high winds was then followed by protracted rain. Arriving after a long drought that made the surfaces impermeable, the heavy rainfall caused extensive flooding, leading to further home destructions but also to the devastation of the crops and a cholera outbreak. Nearly a million of the inhabitants of Tatinya (25% of the population) left the province and sought refuge in other provinces.

The province of Madasa received the largest share of the displaced Tatinyans. Madasa has traditionally been seen as a wealthy, peaceful region with a welcoming culture. It is encompassing forest-covered mountains and a highland plateau, with fairly favourable climate and significant water sources. Its inhabitants mostly practice subsistence economy using archaic agricultural and other production techniques. Coffee has been grown in Madasa for centuries for internal consumption and is now the main export crop. A few decades ago some local entrepreneurs with international experience have also started growing tea. It was soon found that the Madasan “pink” tea, grown in the highest areas of the province, has health benefits and exceptional flavour. International demand has surged. Tea and coffee bring the much needed cash into Madasan economy however they have displaced some of the traditional crops used in human nutrition. Together with the fast growing human population and the climate that is becoming drier, these developments are causing for the first time serious pressure on the environmental resources, with Madasa not being able to produce enough food for its inhabitants.

Displaced Tatinyans are largely living in temporary camps, the largest of which is situated just outside the Madasan capital, Yuli. Conditions in the camps are harsh: although Madasa has enough water, access is difficult; food is scarce and of poor quality, mostly supplied by international aid organizations; and while infections have so far been contained, there is a danger of an epidemic outbreak (food and waterborne but also respiratory such as meningococcal meningitis) that could spread beyond the camp. There is little paid work available for Tatinyans as unemployment is high even among local Madasans. Clashes between Tatinyans and citizens of Yuli have been reported: according to a TV reportage Tatinyans are behind the recent increase in crime in Yuli. The attempt to interview someone from the camps has failed because migrants are afraid of retributions by the local population.

The PM has called an urgent cabinet meeting on how to solve the problem that may explode in multiple directions: as an epidemic, ethnic conflict, crime and even famine. Governors of both Tatinya and Madasa provinces have been invited too. Minister of Foreign and Ethnic Affairs is proposing a quick return of Tatinyans to their home province. She is saying that the government

cannot risk ethnic conflict in particular in the run up to elections (scheduled to take place in 6 months). “This country has been peaceful and prospering under our government,” she argues “We owe it to all Estrelans to stay in power a little longer, to make sure that the democratic order is fully established. Let’s not jeopardize our chances.” She has the support of the Minister of Health who has secured a large international grant (by a private foundation established by an IT billionaire-turned-philanthropist with interest in global health) to rebuild the destroyed areas of Tatinya.

However these two ministers are opposed by the Minister of Environment. “I understand the Minister’s viewpoint,” he says, “I share her fears. But these short-term solutions are a waste of money; in two years’ time we will be having the same conversation.” Cyclones are not new to the coastal regions of Estrela. It is true that the climate change is making them and their impact stronger, but much of the worsening impact is caused by human practices: rampant deforestation, ongoing urbanization, construction of buildings and homes too close to the sea and riverbeds. “Instead of rushing to build a cheap version of the former Tatinya only to be destroyed three years later, let’s consider this disaster as an opportunity to rethink how people may live in future and how we may plan for that.” The Minister is proposing to bring together a team of natural and social scientists to create a plan for new Madasa. He has the cautious support of the Minister of Food and Agriculture, who has been arguing that the country must think seriously about its food production: although monocultures are very important for economy, abandoning traditional crops and mixed farming could expose farmers to high risk should climate turn more unpredictable. However the governors of both Madasa and Tatinya are strongly against this proposal, both wanting to resume the previous state (for different reasons). Minister of Health is worried that the government’s taking time to plan could be interpreted as internal disarray and incompetence by the international donor, who could withdraw the offer.

The PM is undecided: unofficially he likes the Minister of Environment’s proposal but the needs of the displaced population are great and the political pressure to do something quickly is huge.

What would you suggest?



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INGSA CASE STUDIES

FREUDANIA:

Youth Mental Health

Peter Gluckman



FREUDANIA

Youth Mental Health

Background and context

Freudania is a relatively secular Asian Country with a population of 13 million. Its GDP is US\$14200 per capital and with a GDP growth rate predicted for the coming year of 3.7%. It has undergone remarkable economic transition since its independence some 45 years ago. Its economy has been transformed from a commodity-based food (rice, tea) and minerals (coal) exporter to being seen as a new “Asian Tiger” as its economy is now based on technology and innovation: it is a centre for both animation and gaming entrepreneurs, health technologies (especially IT based devices) and for cybersecurity software. It has a centre for quantum computing which is ranked in the top 10 in the world.

The capital is Asta, which now has a population of 4.2 million. Asta is known as a ‘smart city’ with many high-tech sensor systems being used to make for an efficient and clean city. Most people now live in modern apartments and few areas of historical slums remain. It is a parliamentary democracy and the Prime Minister is a former professor of mathematics. The major party in power is business friendly and seen as socially conservative appealing more to the older generations and provincial communities. It is in coalition with a small nationalistic right wing party. The opposition comprised two parties in informal coalition - one is derived from the trade unions and one, which is a “green party”. Thus, the opposition is seen as more environmentally friendly, socially conscious, supporting more progressive taxes and appeals more to the urban technology orientated and younger elements in the community. The last election saw the government win by a narrow majority and political commentators think the government could lose the next election.

The population is polyglot with two major ethnicities, each representing about 45% of the indigenous population. These two groups differ in religion and custom. Although there were some ethnic tensions in the early years after independence, successive governments have worked hard to create social cohesion. This has been achieved in part by a heavy focus on education and creating a sense of national pride. In the early years, national service was compulsory for both males (in the military) and females (in social work) as a nation building programme, but this was abandoned 25 years ago, as it was no longer seen as necessary. One aspect of nation building has been in promoting sport and Freudians have done well at the Olympic games especially in the martial arts, archery, shooting and in swimming. However, many have complained that all the money goes into elite sports and not into community sports.

Because of this relative stability and a commitment to a rule of law, a large number of multinational companies, especially in those advanced technology have regional centres in Freudania and there is a vibrant start-up community. As a result, 25% of the population of Asta are not from Freudania – about half are Westerners and about half from the region.

Consumerism has taken off with all this success. 90% of children have a smart phone by the age of 10. Most in the middle classes have credit cards by the age of 14. Success for children in Freudania now depends on getting into the best schools and best universities. The competition for success even starts at preschool with some kindergartens having entry tests. Even parents from lower socioeconomic families drive their children in a very exam conscious way, insisting that they stay home after school doing extra study.

Asta's most important paper (and online version) is the Asta Herald. The same company also owns the most popular television channel. About two years ago, a reporter for the Herald started a series of articles about adolescence. The first stories were somewhat sensationalist focused on stories of 10 year-old girls having their first periods. They tried to link it to an agricultural chemical factory operating in the suburbs. But the national University's leading professor of pediatrics pointed out that now about 30% of girls in rich countries enter puberty by the age of 8 so there was nothing unusual in many girls having menarche (first period) by the age of 10. It was indeed a sign that child health had improved. Then a psychiatrist pointed to a paper from Finland suggesting girls who had early puberty were more likely to use drugs and alcohol at an early age, and to a paper from Denmark, which suggested that girls who had early puberty were more likely to get bulimia or anorexia.

This led the reporter to start more serious investigation. She started to look at all sorts of aspects of puberty and adolescence. She reported that work from the USA showed that brains did not fully mature until the third decade and because the last parts of the brain to mature were those associated with judgement, this explained risk taking behaviour in adolescence. Research from New Zealand reinforced this finding, pointing out that risk-taking behaviour was an evolutionary norm in young people.

The reporter went on in her series to explore how young people formed social relationships including how many friends they had on Facebook, how honest they were with their parents about their activities on line. At this time, several girls were admitted to hospital having taken overdoses of paracetamol – fortunately, none died. The reporter then appeared on TV and claimed that having interviewed the parents of some of these children, it appeared that each of these girls had been body-shamed by their friends via Instagram in the days prior to their overdosing.

At about the same time the police became aware that more and more young people were being found in bars below the legal age. Indeed in the holiday season at the end of the school year, hospitals were reporting admitting drunk adolescents; boys more commonly than girls. Letters to the editor argued this was the downside of so many foreigners 'invading' Asta. A populist politician from the nationalist party striving to get selected as party president picked on this and started rhetorically claiming that the influx of foreigners were breaking up family structures (divorce rates had increased over the last two decades), that they were bringing drugs and alcohol into a milieu which previously had not heavily used them, and that they were undermining traditional values. This outburst led to an outbreak of bullying of foreigners in several secondary schools. Some of these children had refused to go back to school. The parents of these children went to the media to show the horrific threats that had been made to some of the children. The Ministry of Education had responded by expelling two boys who had been identified as bullies, but the parents insisted that many more youth were involved.

The Herald decided to start a series of articles written by young people. One widely read article published on the editorial page said “old people did not understand young people, all old people wanted are more money for their retirements, while we, the young generation, are more concerned for our futures – climate change is threatening that and the government are doing nothing - we are scared”.

Letters flooded into the Herald – ‘young people have it lucky’, ‘they have lots of choices in their lives’, ‘all young people want is to be celebrities or influencers rather than really work’, ‘young people need to get real and contribute properly to our society’, “we should reintroduce national service”. A retired psychologist wrote an op-ed saying social media had created a race of narcissists - all under the age of 25.

At this time, the Department of Public Health in Asta University published the results of their wellbeing survey. It suggested that there were increasing rates of mental ill-health in people under the age of 25 over the past decade. The Minister of Health claimed, in response to questions, that the survey was totally flawed and the Ministry’s own data did not support this. However, despite requests from the media, no official data was provided. So then the Asta Herald searched corners reports and pointed out that in the past two years more than 50 young men had committed suicide by jumping in front of underground trains. They said this seemed to be a high rate by international standards. The government insisted that these were not high rates: rather that other countries under-reported suicides for religious reasons, and anyhow there were sufficient mental health services as evidenced by the fact that waiting lists for psychological services were not long. The professor of psychiatry responded in the media that psychiatric services were indeed underfunded and the reasons for short waiting lists was because people, especially young people, feared the stigma of being termed mentally ill. It would affect their social lives and reduce their chances of getting into a good university or a high paying job. The Prime Minister entered the argument by saying that young people just needed to ‘grow up’ and he announced a \$40 million initiative to build better faculties at sporting clubs and that if young people joined these, they would be better people.

The Medical Division of the Academy of Freudania decided that addressing the issue of youth mental health was a priority. They established a panel to explore the factors involved.

How would you structure and compose that report?

One Year Later

The report seems to have no response.

The Prime Minister's nephew, aged 19, commits suicide by jumping in front of an underground train in Besta, Freudian's second city of 2 million people. Now, the Prime Minister had a personal interest in what was going on. The media is all over it. **What should the academy do now?**



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CASE STUDY – SCIENCE ADVICE WORKSHOP

GONSWANA

Food insecurity and new technologies

Néhemie Donfagsiteli Tchinda, Justine Germa Nzweundji, Brïte Pauchet and Rémi Quirion



Gonswana

Food insecurity and new technologies

Note: The elements presented in this case study are fictitious and must not be interpreted as real people, locations or events.

Background

Gonswana is a constitutional republic that elects a president every seven years and representatives every five. The nation's topography is diverse, ranging from semi-desert to lush forest and plateaus suited to agriculture. Thanks to favourable weather conditions, Gonswana is primarily agricultural. It is home 52 million citizens, and its gross domestic product per capita is \$1 250. Certain regions, in which a small number of luxury ecolodges are in operation, are popular nature tourism destinations.

Despite its progress, Gonswana remains one of the region's least developed nations, relying on modest income from corn, lumber and oil exports and its budding tourism sector. Surveys conducted following a recent drought reveal that the country's weak economic growth, chronic food insecurity and the social impacts of rapid urbanization are sources of concern among citizens. Indeed, in the last few years, Gonswana has experienced major agrarian changes. Approximately 70% of Gonswanans earn a living through agriculture and livestock production. Agriculture practices are mainly traditional and for subsistence, and farmers are not always able to keep grain reserves from one year to the next. Several foreign entities have acquired a large number of acres—nearly one-third of the country's arable land—to implement an intensive agricultural system for export. Local communities see a threat to their traditional ways of life and employment prospects and fear they will not be able to support their families.

International experts affirm that, with climate change, Gonswana will face more intense cycles of drought and rain that will impact crop growth. In addition, in three of the past five years, the rains that followed a particularly severe drought fostered the emergence of swarms of locusts in several countries in the sub-region, forcing many families to leave their communities for towns and cities in search of work.

A decade ago, Gonswana adopted a policy regulating the use and marketing of genetically modified organisms (GMOs) in an effort to reconcile the country's specific ecological characteristics and economic constraints. Since then, the government has encouraged the use of modified seeds to stimulate yields and corn exports to the detriment of traditional seeds. To address the production gap, the government has implemented an agricultural strategy that supports the use of crop protection products and chemical fertilizers. Because Gonswana does not possess the necessary infrastructure, foreign multinationals dominate the seed, fertilizer, herbicide and pesticides markets.

In several regions across Gonswana, local communities are expressing their concerns regarding monoculture, which, they believe, has damaging effects. They do not understand why they must source their seeds from foreign businesses year after year and fear they will not be able to purchase them should a regional political or economic crisis arise. They also express concern over the rapid disappearance of milu—an ornamental and medicinal plant used in many traditional Gonswanan ceremonies.

Issue

A research consortium including eminent experts from the National University of Gonswana recently announced that it was about to launch the final phase of its new locust control method. Using a gene editing technique, the researchers were able to alter the pheromone gene leading to the development of locust swarms. When locusts whose gene has been altered are released into a swarm, their pheromones disrupt the behaviours of wild locusts by preventing them from swarming. The researchers affirm that the insects are not a risk for humans and that their release has no negative environmental impacts. The researchers consider their method to be a model for safe biological control.

Food for All, a non-profit organization, is the project's main financial partner. It is currently in negotiations with the government of Gonswana to carry out tests under real conditions this year. The effort will involve a number of Gonswanan universities and research centres and could lead to the creation of a high-tech centre to develop locusts with the edited gene. The technology, which would serve all countries facing locust swarms, could position Gonswana as a regional leader in research and development and, in time, represent a key source of income.

The FAO's locust information service, which conducts daily monitoring of the ecological conditions leading to swarms, notifies the government of Gonswana that a major swarm is likely to occur in the Mendou region within the next four to six weeks. Given the situation, local authorities have established a chemical control plan to limit damages but are slow to implement it. In Mendou and the surrounding areas, there are rumours that the government will release the insects to destroy the crops of farmers who did not vote for the ruling party in the last elections.

At the same time, an association of monoculture farm businesses is pressuring national and regional governments to implement measures as soon as possible to curb the swarms. Some members are working to facilitate the release of genetically modified locusts, though there has yet to be a public or policy debate on the technology's social acceptability.

Needing to act quickly, the government of Gonswana consults its scientific advisor on the possible scenarios. What elements should the government's scientific advisor consider in her report?

Photo: Swarm of locusts in Madagascar, Iwoelbern, [Wikimedia Commons](#)



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Ileojogbon: a fictitious case study

Legislating Homosexuality

Prepared by INGSA Africa Steering Committee

CONTEXT

Ileojogbon is a low-income country in tropics of Africa with a population of 37 Million people and a GDP per capita of US \$ 300. The major sources of income for the country are coffee, cotton, vanilla, and tourism.

Recently, Ileojogbon has been the recipient of harsh criticism from some of its middle-income allies/trading partners in Africa and countries in Europe and North America over its pursuit of a Private Member's bill to curb homosexuality in Ileojogbon. The bill, not moved by the Government, is known as the "anti-homosexuality" bill meant to criminalize homosexuality in Ileojogbon. The current bill (which may become a law if the country's parliament debates it, votes to turn it into an Act of parliament, and the President of Ileojogbon assents to the Act) provides for 20-25 year prison terms for anyone deemed, by society, to be openly homosexual or in a homosexual relationship. It also provides for 2-3 year jail terms for those who knowingly harbor homosexuals. Additionally, the current bill provides for life imprisonment for any homosexual who trains a child or young adult to become a homosexual. The bill is currently being amended to also include lesbian and transgender communities so that it is more comprehensive and thorough in its reach.

Moreover, the bill enjoys widespread support amongst the ruling and opposition parties. Members of Parliament (MPs) of both parties have joined forces to support the bill and also mobilized some civil society organizations to support the bill. However, there are some MPs who are hesitant to publicly comment on the issue, but have been known to break ranks with their parties on matters they have openly or silently disagreed upon with their party structures. Religious leaders of the most dominant religions (Christianity, Islam, and Traditional) in the country have issued statements through their joint platform, the Inter-Religious Platform of

Elders, in support of the bill as a moral obligation. About 50% of the cultural leaders in the country have also supported the bill publicly. The other 50% remain silent and choose not to comment when media outlets ask questions about the issue. Those in support of the bill claim that homosexuality is not part of Ileojogbonian culture.

On the other hand, human rights advocates, legal scholars, gender studies professors, anthropologists, historians, novelists, and sociologists have also publicly raised their voices against the bill. They claim that the bill is draconian, inhumane, and an infringement on fundamental human rights. They also claim that there is a diversity of human sexuality across cultures, nations, and continents. They also claim that cultures in Africa have long tolerated and accepted non-heterosexual practices as long as they were kept private. Advocates against the bill claim that any attempt to politicize sexuality is to win cheap votes and encourage prejudice in society. They also claim that Ileojogbon should join the 21st century and be more accepting of minorities in all their forms. All these groups have sway over public opinion of government and they have won some hard-fought battles on sensitive issues in the past (e.g. voter fraud, female genital mutilation, corruption, land tenure, forced migration, and access to antiretroviral therapy).

THE OPPORTUNITY FOR SCIENCE ADVICE

The Prime Minister, as the leader of government business in the Parliament of Ileojogbon, has exactly 3 months within which to present a position on the bill and its amendments. At that point, she will have to get the buy-in of the entire cabinet on any position she takes in order to give an official government response to the Private Member's bill in parliament.

The Prime Minister of Ileojogbon has requested top scientists in her country to provide her with advice on the supposed spectrum of sexuality in her country. Specifically, the Prime Minister would like specific answers to the following questions:

1. Are homosexuality, lesbianism, and any other expressions of sexuality other than heterosexuality a matter of genetics?
2. Can non-heterosexual expression be cultivated in human beings, especially children and young adults?
3. Are homosexuals and other non-heterosexuals a danger to society in terms of physical, psychological, and cultural violence?
4. What is the role of homosexuality in disease transmission?

5. Is there scientific evidence of increased infection among homosexuals for certain diseases (e.g. HIV)? Is there associated health risk for the community?

Ultimately, the Prime Minister would like these top scientists to advise her on whether Ileojogbon should adopt a law criminalizing homosexuality, lesbianism, and any other forms of sexuality other than heterosexuality.

How would the science academy go about assembling sound evidence to answer this question within two (2) months so that the Prime Minister has enough time to take scientific information and recommendations into consideration as she table a position paper on this issue to the full cabinet? You have budget constraints and the number of scientists willing to serve on any committee to answer these questions is low, except, of course, those scientists who are already publicly seen to be in support of or against the anti-homosexuality bill.

INGSA CASE STUDIES

INNOVANDIA:

Smart city networks and AI for solving societal problems

Anne Bardsley, Tatjana Buklijas and Peter Gluckman



INNOVANDIA

Smart city networks and AI for solving societal problems

Background and context

Innovandia is a small developed country with an ethnically diverse population of 8.5 million. It has a democratically elected single-chamber parliamentary government, which is currently a coalition between two centrist parties: the Futures Party (FP) whose constituency is mostly the younger voting population with a focus on sustainability and a high tech future, and the Prudential Party (PP) which is positioned to the right and seen as a business friendly neoliberal party.

Innovandia has a stable economy traditionally based on a mix of exports of high-quality primary products (from agriculture, horticulture, fisheries/aquaculture) and tourism, more recently augmented by a range of emerging high-tech industries. It has invested heavily in AI-related research in its universities and in providing subsidies to hi-tech industrial parks as part of the government's future-focused agenda, which has attracted several major multinational digital companies. It has also benefitted from increasing global connectivity that has spurred the trend towards a high-tech, knowledge-based digital economy. The citizenry has rapidly adopted digital habits including a high use of social media and online shopping.

Innovandia projects the image of being a good global citizen, promoting a sustainability agenda. The country has had a high profile as a socially liberal country, and has received a large number of refugees from dysfunctional countries in the neighbouring region, where there is considerable ethnic and religious violence. Further, the government has had an active immigration policy, believing that immigration fuels economic growth. Simultaneously it seeks to attract foreign direct investment and multinational companies by promoting itself as a magnet country for talent in the high tech industries.

The vast majority of Innovandia's population now lives in and around its urban centres. The Minister of Science and Innovation (from the Futures Party), with support from the PM's policy advisor on innovation, has pushed for 'smart city' solutions to accurately gather, analyse and act on information about urban systems to improve resource allocation, manage waste, reduce traffic congestion, and provide better and cheaper utility services. Their coalition partner (PP), while initially sceptical of the cost-benefit had agreed seeing the potential to also use surveillance systems to reduce crime and enhance public safety. In turn, as the party having control of the finance ministry, they had argued that the use of 'big data' analytics and the application of algorithmically-informed decision-making promises increased fairness and efficiency in the delivery of essential government services such as social welfare and mental health services.

The Minister of Police, also from the PP, had returned from a meeting of OECD police and justice ministers and reported on the success of predictive policing in major urban centres in several countries. The Commissioner of Police supported this view strongly although a respected Professor of Criminology at one of the universities had argued that the evidence for the success of predictive policing was very weak.

Artificial intelligence (AI) is already being used by several banks including a government owned bank to determine loans, by the immigration agency in determining visas, to assist judges in sentencing, and big data is being suggested as a way to identify at risk children early in life for targeted welfare intervention.

While AI holds significant promise, there are also significant challenges in the rapid push to integrate these systems into high stakes domains. The central government has identified 'big data' as both a strategic priority and an area of ethical and legal concern. In response to growing public concerns both domestically and as a result of well publicised international issues involving social media companies, it has recently established a Digital Governance and Ethics Advisory Board (DGEAP) that reports to the Minister of Science and Innovation (from the FP) and Minister of Justice (from the PP). That Board wants the government to be more proactive in regulating digital innovation, but the Cabinet worries that regulation beyond current privacy and libel laws (which have not been tested in relationship to digital information in court) might stifle the very innovation agenda that brought both parties to power.

But privacy advocates raise concerns about the quality of the privacy regulations and the protection of private data. They also argue the need to ensure that the government's use of AI doesn't create unintended discriminatory consequences. They cite North American evidence to suggest such biases are inevitable.

The issue

Innovandia's biggest city, Esterbridge, is both the financial centre and the centre of innovation. The largest science innovation park, housing numerous start-ups and several multinational companies, is based there around a National AI Research Institute. This innovation dynamic has spurred a lucrative market for technology and telecommunications companies (both local and multinationals) for developing digital and networked solutions, and with this, a growing ability to capture, aggregate and process an ever-greater volume and variety of data. In addition, the proliferation of personal devices capable of collecting and transmitting information to the internet and to databases has linked most Innovandians to the growing 'Internet of Things (IoT)' – a massive web of people, data, things and processes interconnected via a dynamic, global digital infrastructure.

However, the growing population, housing shortages, relative ghetto-isation of some ethnicities and migrant groups within the city, pressures on natural resources, pollution, and claims of rising rates of violence and crime have led to a rise in populism at both ends of the political spectrum and within one faction of the Democratic party. The palpable shift in the political dynamic is increasingly commented on by political commentators. A rising projection of a dystopian future is appearing in the political and media discourse, which is being exploited by the leader of the major opposition party.

Health and social services, school services, and infrastructure, including roads and public transport are also under pressure in Esterbridge. One multinational digital company, having initially announced it would have a major research centre in the city, its first in the region, has now decided to not do so but rather base itself in a neighbouring country. The company spokesperson stated that changing circumstances in Esterbridge make it no longer as appealing for attracting and retaining high quality staff, but the decision was likely prompted by the murder of two of the staff from their small commercial office in Esterbridge – a husband and wife team – in a highly publicized metamphetamine-fueled home invasion.

Some commentators, including some very distinguished academics, are claiming that drug use and associated crime are largely arising from parts of society which have little hope, being stuck in the cycle of transgenerational disadvantage. Populist politicians are however claiming that it is the refugees and recent migrants that are responsible and want the government to greatly reduce immigration and the refugee quota. The media debates, as well as the intense coverage of disturbing cases such as the mentioned home invasion, seem to have influenced public perception of crime: while the crime rate has

actually been steadily falling, surveys show that 75% of the population believe the crime rate is rising rapidly. A major property developer has fueled matters further by announcing the development of a gated community with 24 hour security to appeal to the upper end of the market. The societal discourse is becoming more polarised and the political dynamic increasingly appears to reflect that.

Approaching the crime problem

Esterbridge has been investing in a strong digital infrastructure with extensive traffic and environmental sensors. According to the mayor's public statements, street crime in the downtown has reduced thanks to a number of digital cameras that have been installed in the downtown by the City Council. The city has paid for many of these to be now linked into the central police station.

City officials rely upon data analytics to support a number of initiatives, including traffic, environmental and utilities management. More recently big-data software companies have sold software and AI services to the Esterbridge Metropolitan Police Department (EMPD) that apply computer algorithms to predict where crime is likely to occur, based on property data, social media, historical crime statistics, and other data on the local community and its residents and visitors. This has been used to plan where the police force should be deployed: so called predictive policing – an approach that has been contested as to its effectiveness overseas.

Recently, under public pressure, the city issued a request for bids for an integrated video management solution that would allow the city police to better monitor a number of suburban localities identified as being at highest risk for crime. Cyclops Inc., a domestic company, 75% owned by the large multi-national Advanced Informatics Technology (AIT), won the bid and began replacing traditional passive CCTV surveillance cameras in suburban shopping centres and neighbouring streets with intelligent video sensors to alert suspicious activity to the monitoring agency (mainly the police). The contract allowed for the potential to introduce facial recognition software into the sensor system, but city councillors have not agreed to fund that update as yet (though the vote margin was narrow). But the system continues to evolve, with novel uses for the video camera feeds added in by multiple departments including parks, transportation, emergency management, and public facilities. The data provided by the cameras is now linked to automobile number plate recognition technology, developed for use on the toll roads.

In response to the home invasion murders, a well established lobby group (Reduce Crime and Protect Survivors ; ReCaPS) has demanded further expansion of the crime-prevention initiatives. They have developed neighbourhood watch groups and have demanded access to the CCTV feeds. They have also raised money to sponsor a Private Security Camera Incentive (PSCI) programme, which encourages residents, businesses and social organizations to install security camera systems on their property and register them with the police.

Capitalising on this potential opportunity to enter a new market aimed at private homeowners, Cyclops developed a video-enabled door buzzer with connected security camera, which sends an alert to a smartphone when someone is at the door, and saves video footage online. This allows the homeowner to monitor deliveries, record theft of packages, and identify suspicious persons on their property. Cyclops can at least in theory link the data to its other real-time crime monitoring systems already installed throughout the city.

Cyclops has heavily marketed their smart door buzzer devices to both the public and the police as a means to increase public safety and reduce crime, and their device carries an endorsement from PSCI. But the evidence on which their claims are based is purely anecdotal. Nonetheless, insurance companies have

offered rebates to homeowners to install the buzzers, and ReCaPS has provided them for free to a selection of residents in high-crime areas in the hope of catching offenders and essentially providing 'herd immunity' to burglaries and other crimes in those neighbourhoods. The local police chief and mayor attended the ceremony in which the first free device was installed.

Cyclops also has market dominance on police body cameras and their parent company has a number of data management contracts with the Government including maintaining the immigration and customs databases. Their cloud-management data storage service (provided for a monthly fee) ensures long-term contracts with EMPD.

AIT and Cyclops have patents between them for potential uses of their smart cameras that would be enabled with facial recognition technology, a development allowed for in their police contract. The additional feature would allow comparisons of facial images to a 'database of suspicious persons'.

The Cyclops CEO, in a well-broadcast interview on a programme on new technologies, has discussed the potential value to the homeowner of technology recognising someone 'suspicious' on the homeowner's doorstep; it could alert the homeowners, and would also retrieve additional information about the person from the database, which would be accessible by police. Homeowners would have the ability to add visitors to an 'authorised list' if they are known to them.

One of AIT's major developments has been in advanced facial identification technology. It claims to have over 500 million faces in their database which has been extracted from Facebook and other sources. In some countries it has contracts with their immigration and police agencies to have access to their databases. They have not yet formally approached the government of Innovandia but they have engaged a former Minister of Police as their Innovandia advisor.

Neighbourhood crime prevention groups are already using mobile phones for monitoring and communicating about suspicious activities. The potential to link to AITs' facial recognition technology through private door buzzer cameras would allow more detailed information about suspicious people to be shared amongst the community watch groups.

A national weekly magazine has published an 'expose' of AIT claiming that they are seeking ways around Innovandia's privacy policies. In the same issue, a retired high court justice wrote an essay arguing that new technologies are undermining basic privacies and could lead to undermining of the justice system. This debate has now entered the political arena with editorials in different newspapers taking different views. ReCaPS have started a major publicity campaign to support more use of facial recognition software, while civil liberties groups are taking a different view, citing a distinguished academic who claims the facial recognition software is not very accurate in particular when recognising/distinguishing people from ethnic minorities. Both police and criminal justice in Innovandia have a history of biased treatment of some minorities and given the publicity around several recent cases in America of fatal misidentification of black men based on 'automated suspicion' algorithms, there is a growing chorus of dissent against the use of such technology by police.

The Crime Research Unit and the AI Research Institute are two components of the University of Esterbridge: they have just received a major research grant for US\$25 million from offshore to use the growing data on crime in Esterbridge to explore the social precedents of crime. Their grant application indicated that the use of large data bases linking educational, health, welfare and justice data around identified individuals would be the basis of their research. While their application did not mention facial

recognition, they are excited and have indicated to the Minister of Justice and Minister of Science and Innovation that the use of AI facial recognition would lead to major breakthroughs with global implications, and would have many spinoffs.

Meanwhile, it has come to the attention of privacy advocacy groups that the umbrella company of Breakwell Insurance – the largest insurance company promoting the use of the smart door buzzer devices – is also a shareholder in AIT. The question of whether these three companies are sharing data has been raised by an investigative reporter. The companies fiercely deny this.

Public oversight and regulations (including Innovandia's Privacy Act) have not kept up with the rapid evolution and uses of these technologies. Both local and central government of Innovandia are now faced with the challenge of deciding how and when such surveillance data can be used – an issue significantly complicated by the fact that the technology for gathering it is proprietary, and the data itself is also in the hands of private enterprise. The major opposition party (People First Party PFP) is seeing an opportunity and is demanding action to limit the technology. ReCAPs not surprisingly has taken the view that the technology must be introduced. Rival petitions to parliament are being circulated. Technology companies are beginning to wonder if they are welcome.

The Prime Minister feels the debate is getting out of hand. There are multiple issues and as a starting point she needs to have an urgent report and she asks the relevant minister to set up an ad hoc committee to look at the issue.

The committee consists of:

1. The Chief Science Advisor (chair) – PM's knowledge broker on science and technology issues to inform policy
2. The Privacy Commissioner – tasked with protecting the privacy of Innovandia's citizens
3. The head of Innovandia's Innovation Agency – a government agency tasked with promoting development of private sector innovation
4. The Justice Sector Science Advisor – knowledge broker for science issues impacting police, customs, and justice
5. The government Chief Information Officer – responsible for the government's data management
6. The spokesperson for the Organisation of Innovandia's Mayors – representing local government issues
7. Innovandia's Human Rights Commissioner – promotes and protects human rights according to the Human Rights Act
8. The PM's policy advisor on Equity and Ethnic affairs – advises on cultural sensitivity issues, diversity, etc
9. The President of the National academy of Arts and Sciences – representing academia in humanities and sciences
10. The President of the Institute of Engineers

Exercise

You are appointed as a member of the panel to discuss these issues and synthesise multi-stakeholder views and evidence for the Prime Minister

***Not for distribution

Wider lessons and insights

The problem here is not the willful misuse of AI. It's that AI and related technologies are being used without processes or standards to ensure safety or fairness, or without a deeper consideration of their complex social interactions.

Issues include:

- lack of regulatory oversight,
- lack of agreed principles for data use/sharing
- a constantly-changing technical landscape which significantly influences the evidence basis and can change ethical, social and legal aspects of the public-facing debate.

Discussion points:

- **Issue framing** by different groups (including govt): How might this influence policy development?
- **Who owns the data?** Policing, surveillance, crowd control, emergency response are traditionally part of state functions. Citizens might expect sensitive data to be held by the state. But local governments depend on public-private partnerships to develop the analytics necessary for "smart" urban systems, meaning much of the data is held by private companies
- **Transparency vs company IP:** An important issue is lack of transparency of the proprietary algorithms and technologies. Black-box operating systems mean the city/agency loses control of critical information and data – the corporation controlling the data and analytics becomes the 'command centre'. This might lock agencies into proprietary systems
- **Trusting machine learning over professional judgment.** *In 2009, for instance, San Francisco police handcuffed a woman and held her at gunpoint after a license-plate reader misidentified her car.* – Officers trusted the machine over their own observations that the model and colour of the car were wrong. This relates to fundamental issues of police discretion and accountability when utilising technologies for "automated suspicion" (Joh, 2016 #760) –
- **Responsible innovation?** --relevant for engineers: do they need to just think 'what's possible' but also 'what kind of societal and environmental impact might my work have'?
- **Should we address the issue of 'disruption'** – is disruption a good thing?

QUESTIONS / EXERCISE

1. Can you identify technical questions that can be answered in a relatively straightforward manner (assuming the appropriate expertise is available) – even where there is likely to be disagreement on whether (or how) the government should act on that advice? (i.e. the technical question is uncontroversial, but the social/political question is very controversial)

2. Present the most relevant issues from the perspective of

- A Cyclops engineer /spokesperson for industry
- The Crime Research Unit and the AI research centre

- The Esterbridge Metropolitan Police
- Reduce Crime and Protect Survivors (ReCaPS) victim support lobby group
- Innovandia central government
- Esterbridge city council
- A group representing minority residents of a high-risk neighbourhood of Esterbridge

In addressing the issues, consider both friendly audiences and those likely to oppose, even when you seek to influence policy in a particular direction

Can your argument be supported by technical analysis and evidence? What further information might you need? Have other groups developed similar positions, and if so, on what basis?

What might need to be explained to policymakers (and other audiences) on how these powerful tools can be used in such a way as to ensure maximum benefit while minimizing risks?

INGSA CASE STUDIES

ISLANDIA

Addressing childhood obesity between science, economic interests and
local knowledge



ISLANDIA

Addressing childhood obesity between science, economic interests and local knowledge

Background and context

Islandia is an island in the Caribbean. It has one large volcanic based central island of 8,000km² and several small, low-lying keys. About 85% of the population of 280,000 live on the main island. Urbanization is increasing and the traditional village population shrinking, with about 65% of the population now living in the capital city. The GDP of Islandia is USD5,900/capita and is rising quite quickly as a result of tourism growth and remittances. The major exports remain fruit, rum, spices and fish and some low-end watches assembled from imported components (this employs some 300 Islandian women in assembly line work, but the company is a sub-venture of a Majorian based company and it pays very little in the way of tax). The country also receives developmental aid from several countries, but most particularly from Majoria. Majoria is the region's most populous and economically advanced country, which also hosts a considerable percentage of the Islandian diaspora.

The Islandia population has recently grown very rapidly, because fewer young Islandians are able to obtain work visas abroad. Instead, more of them are looking for work at home, largely in tourism, and to starting families. Many of the young adults have no marketable skill sets and unemployment is high outside the tourism sector. Crime is high too. International tourism has brought a growing consumerism, especially in the capital city, which also hosts the only international airport, and in the towns around tourist resorts. Rapid growth of urban centres, poor urban planning with limited public transport and no safe and green spaces, liberalization of car import policies, as well as rise in crime, have made people fearful of outside activities and is resulting in the reduction of physical activity.

In the past, Islandians suffered from under- and malnutrition caused by food insecurity and parasitic infestations. A previous administration assisted by aid agencies and advised by the WHO and FAO rolled out a "10-Year Plan" to address these problems, using multi-sectoral programmes. So far, the interventions (including fertilizer subsidies, providing farmer education and support, diversification of crops) have almost eliminated famines, severe food insecurity and severe undernutrition. Micronutrient deficiencies have been significantly reduced through supplementation. The prevalence of parasite infestations has been lowered through deworming programmes with some improvement in the nutritional status of all the segments of population.

Yet the arrival of fast food chains, the increased consumption of soft drinks and a decline in traditional fish consumption, much of which is now devoted to export markets, combined with lowered physical activity, have now pushed the balance the other way. Obesity is rising rapidly in

children and in adults. According to a survey conducted by a visiting university team, about 35% of children at the age of seven are obese. Heart disease and type 2 diabetes, generally appearing before the age of 50 and sometimes even in teenage years, now confront nearly every family and are overwhelming the national medical services, the latter taking up 5-8% GDP.

A recent report from the Regional Office of the WHO highlights the major problem of childhood obesity in Islandia. A number of initiatives are now promoted both by the government and by donor countries. Most of these are focused on nutritional education in schools and on promoting physical exercise. The Minister of Health wants to ban fast food outlets from selling to children under the age of twelve and put a tax on sugar sweetened beverages, but there are objections from some families and the powerful owner of the biggest fast food chain.

At the same time, a Majorian company has approached the government to say that it has developed a special diet drink for children that is partly made with soy milk, an Islandian local herb and molasses. The inventors of this drink, called CLEVERKID, have claims that include giving CLEVERKID to children from age 3 will reduce the risk of obesity, and that one can of this drink a day is a preferred lunch replacement for maintaining a healthy weight and will help them learn better. The company is seeking a concession from the government to build a plant to make this meal replacement product and to be exempt from taxes and import levies on the import of the other materials for its production and sale. It is anticipated that CLEVERKID will cost slightly less than the soft drinks currently available in fast food outlets and the local markets. The company is offering to provide the product at cost to schools and it intends to export it to other countries in the region and perhaps beyond.

Scientists from the local university have recently been made aware of the company's proposal to the government of Islandia. They are stating that this 'milk' contains large amounts of molasses and thus has a high content of sucrose. The university's leading nutrition researcher (who is the former graduate supervisor of the current Islandian Minister of Health) claims it is irresponsible to promote this product as a healthy part of children's diets. She is pointing out that any health claims for it are not based on any randomised trials and that the label is misleading. The company counters this criticism with the argument that all health claims come from traditional knowledge, because the drink is an artisanal version of a recipe that has been given to the children for generations. Furthermore, the government has learned that an international NGO, The International Indigenous Herbal Medicine Foundation (IIHMF) that works in the bio-prospecting space, is giving licensing advice to the consortia of family groups who own the herb plantations.

The Majorian ambassador to Islandia makes it clear to government members that Majoria would be very pleased if consent was granted and a deal could be reached for distribution of the new diet product in schools. She points out that Majoria is considering building a new airport on the main island, a major highway infrastructure project and tourist hotels. The deputy Prime Minister, who is up for re-election next year and is the Minister for the Economy, comes from the Parish where the herb is grown. The family groups who grow these herbs believe that the price they will get for the raw herbs will double their income. They have made it clear to the deputy Prime Minister that they expect him to make sure approval is given to approve the diet drink.

The dilemma

The Prime Minister is in a quandary – he knows that obesity is a major issue and is sceptical of the health claims. The Minister of Health is in agreement. She is proposing to introduce mandatory food labelling of all products including natural ingredients, such as the “diet drink”, and taxing those containing more than 10 grams in 50mls of fluid of sugar, as a way of controlling intake of sugars and providing income to the health sector. But the Minister of Foreign Affairs and Minister of Finance think it is more important to maintain strong relations with Majoria and the new industry could offer valuable opportunities. And the Minister of Culture and Heritage strongly believes that the herbal product should be supported.

You are the scientific advisor to the Prime Minister and Cabinet, a post that has recently been created on a trial basis. The Prime Minister seeks your advice.

What considerations do you need to bear in mind in doing so? Note: this question is not about making a specific recommendation but rather about the process and considerations in doing so.



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Republic of Jibaji*: a fictitious case study

Construction of a dam and governance of water resources

Resource persons: Alioune Kane, professor and Director of the “Eau, Qualité et Usages de l’Eau” doctoral school at Université Cheikh Anta Diop, Dakar and Kristiann Allen, Chief of Staff, Office of the Prime Minister’s Chief Science Advisor, New Zealand.

BRIEF STATE OF KNOWLEDGE

The countries of West Africa have a large number of major rivers and a high availability of water. However, the situation with regard to drinking water is alarming: according to UNICEF, 40% of the population has a round-trip of more than 30 minutes to the nearest source of drinking water. Paradoxically, the countries with the largest water resources are among those with the lowest levels of drinking water coverage. There is still a lack of water management expertise in Africa, which is the continent with the least water infrastructure (less than 2% of global structures).

In addition to energy production, the construction of large dams for agricultural or hydroelectric purposes should help to: (1) Achieve the objective of food self-sufficiency for the local population; (2) Secure and improve incomes for the local population; (3) Preserve the balance of ecosystems; (4) Reduce the vulnerability of national economies to climate hazards and external factors; (5) Accelerate national economic development.

However, these major structures significantly modify how rivers operate, with many environmental, social and economic consequences. They have been severely criticized in the past for their low return on investment, but progress has nevertheless been made in the Senegal River Valley and the Office du Niger (Mali), where rice farming is becoming competitive with Asian rice imports.

Consequences of dam building

With the development of major water infrastructure, a system of dikes can be used to provide gravity irrigation in low-lying areas. This water management facilitates the development of hydro-agricultural installations and crop diversification on previously unirrigable land in the floodplain. However, downstream from the dam, the water is often more salty than before, raising problems concerning water resources for irrigation and consumption.

The authorities and civil society are concerned about the environmental and health situation in the water sector. First, waterborne diseases still have serious impacts on populations, especially

chronic diarrhoea due to a lack of drinking water and/or sanitation (which also concerns cities that are often subject to water cuts). Second, major wetlands, such as the Inner Niger Delta, Lake Chad and the flood valleys, have seen their surface areas drastically reduced and their biodiversity significantly degraded. Marine deltas are being disrupted by sea level rise, river regulation by large dams and climate change, which are endangering their fragile ecosystems.

The construction of dams has variable and complex impacts on the population of river basins. More often than not, “the shaping of landscapes and lifestyles by the annual flood is replaced by the process of storing and releasing water” (Duvail et al, 2009). The construction of new dams leads to the displacement of local communities, and conflicts over access to land are exacerbated in irrigable areas, because States encourage the establishment of major private investors to improve food production, fuelling concern and opposition among local farmers.

Governance of water resources

On the international level, dam building and water infrastructure have given rise to a number of disagreements (water use conflicts, concerns that the dam will affect another country’s water availability, population displacement, etc.) and even cross-border conflicts. When it comes to the governance of water resources, it is imperative to dismantle the national vision of river basin management in favour of a territorial approach. To that end, there are several inter-state river basin agencies in operation. They provide a basis for effective solutions to sharing the water from major rivers, anticipating tensions and settling disputes. Their effectiveness is nevertheless highly variable and their capacities could be strengthened, particularly with regard to the sharing of accessible central databases for the purpose of conducting studies.

In addition, governance at the local level is of primary importance. As emphasized by GWP (2010), it is necessary to “involve affected populations as project actors, partners and beneficiaries and ensure that all actors involved in project development play their respective roles”. Moving towards participative governance through the establishment of a dialogue with local populations before the project begins is essential for several reasons. First, project efficiency is improved by enhancing the sense of project ownership. Second, population involvement provides a better understanding of the balance that needs to be struck between the actual needs of the people and the realities of the terrain. Local populations are an essential source of information on their culture and environment as well as specific details such as livestock migration and transhumance. To that end, in Senegal during the 1960s, the Société Nationale d’Aménagement et d’Exploitation des Terres du Delta du fleuve Sénégal et des vallées du fleuve Sénégal et de la Falémé (SAED) gave way to local organization among small producers, through the introduction of peasant unions responsible for farm development and water infrastructure management.

FICTITIOUS CASE STUDY: THE REPUBLIC OF JIBAJI*

Jibaji* is a country located in the Sahel region of West Africa. Two rivers run through Jibaji: a principal river that crosses the territory and a secondary river that marks the border with the

neighbouring country of Jamanie*. Jibaji's economy is primarily based on seasonal agriculture and livestock, two activities that are highly sensitive to climate variability. Substantial fluctuations in precipitation over the last century caused several severe food crises, and climate predictions are hardly reassuring in that regard. During the difficult years, many Jibajians abandoned their land, turning to unprofitable informal economic activities such as gold panning.

The regulation of rivers by dams can provide solutions and contribute to the development of West African countries. That is why, 10 years ago, Jibaji* built a dam on its principal river. The benefits of this dam for the local population have proven to be far less generous than those promised by government officials during site visits. There were many negative impacts: displaced populations, degradation of the ecosystem leading to the proliferation of waterborne diseases, problems with access to drinking water, etc. Some displaced farmers were not compensated and their case is still before the courts. The Jibajians who earned their living through gold panning have been deprived of their meager income because of changes in water levels of certain branches of the river, without compensation. The project proved to be economically beneficial for the country, but delays and costs caused by social problems almost compromised its success.

A consensus was reached within the EGAC (Economic Group of African Countries) for the establishment of new water infrastructure, with a view to sustainable economic development. On this occasion, the President of the Republic of Jibaji* made a formal commitment to increase energy production by 40% within 5 years with the construction of a new hydroelectric dam.

A project primarily financed by a foreign investor is currently under study. It includes the construction of a hydroelectric dam on the secondary river, which will increase the country's energy production by 50%. On the banks of this river, water resource management remains largely unstructured. Farmers withdraw water according to their needs to irrigate their small fruit and vegetable crops, by hand or with the use of a cheap motor pump. While this practice is a means of extending the growing season, it creates tensions at two levels. First, at the local level, especially on the outskirts of the town of Dusudòngo*, water access corridors have been high transit areas and community gathering places for many generations. After the rainy season, people flock there for the country's most colourful cultural ceremonies. But when water becomes scarce these corridors become conflict zones, especially between farmers and gold panners. Second, at the international level, the government of Jamanie* maintains that the farmers' withdrawals severely reduce the output of its dam further downstream, contravening the agreement between the two countries. Diplomatic relations are strained in the absence of tangible proof of the impact of water withdrawals on the flow of the river.

The project currently under consideration would involve the resettlement of part of the local population and the establishment of a new agreement with the neighbouring country. The financial backers are open to assuming the resettlement costs and facilitating access to water and electricity for the local populations, but under certain conditions: local projects must be

economically viable, fund management must be transparent, and access to resources should not destabilize the dam's electricity production or international agreements.

As a researcher at the National University of Jibaji*, you contributed to a case study of six large dams built in West Africa. This research supports three conclusions:

- The importance of supporting local development alongside a dam's national goals: this prevents protracted disputes that drain government resources over the long term;
- The transition from traditional resource tenure to management of lands under modern law is the major source of tension;
- Local people affected by dams need their rights codified and protected by written agreements to avoid accusations of broken promises, conflicts within host communities, and litigation around compensation.

The President of the Republic of Jibaji* wishes to determine the conditions under which building a dam would benefit the local population while being economically viable. He intends to negotiate these conditions with the foreign investor and the local populations concerned. **You have one month to write a report outlining the issues that need to be addressed. What will be the main message of this document?**

The Republic of Jibaji*: a fictitious case study

Group exercises

DISCUSSION

Technical aspects for the building and long-term maintenance of the dam

What technical aspects will you bring to the President's attention to guarantee the long-term success of the project? What resources, expertise and data will be needed? Are there any international standards regarding safety and energy production that will need to be met? What about environmental impacts (soil contamination, changes to the ecosystem, etc.)? Should there be a budget for dam maintenance or will the dam generate enough revenue to cover this?

Socioeconomic issues for local populations

How do you envision the coexistence of family farms and large agricultural enterprises? What are the consequences of population resettlement and are there other possible solutions? Is it possible to build a multi-purpose dam? Where will the employees who will operate the dam come from? What will be the local needs for training, management and administration? How can the responsibility for water and energy resource management be shared between the local people and the government?

Issues at the international level

What terms will have to be negotiated with Jamanie*? What information will be needed in order to do so? What guarantees can we offer them? How can the terms of such an international agreement be applied locally? What will be the consequences if Jibaji* does not honour its commitments to EGAC?

Bonus question

You wish to convey to the President of the Republic the importance of investing in water resource management research in order to obtain local expertise. How can this message place you in an apparent conflict of interest? How do you proceed?

**These fictitious names are inspired by Bambara, one of the national languages of Mali.*

ROLE-PLAYING

For this role-play, participants are invited to assume five characters and to envision what their positions would be in four different dam building scenarios. What reservations would they have? What points would they want to negotiate? What proposals would they make in order to serve their interests or those of the people they represent?

Roles:

- The Minister of Foreign Affairs of Jamanie*
- The Jibaji* Peasants Union
- The Mayor of the town of Dusudònko*
- The researcher from the National University of Jibaji* (acting as Advisor to the President)
- The foreign company, principal investor in the dam project

Scenarios:

1- The President of the Republic of Jibaji* is moving forward with the building of a hydroelectric dam that will allow farming of land around the town of Dusudònko*. He will create a river basin agency with Jamanie* to manage water access for the secondary river. The agency's Board of Directors will be made up of equal numbers of representatives from Jamanie and Jibaji.

2- The President of the Republic of Jibaji* is moving forward with the building of a hydroelectric dam that will allow farming of land around the town of Dusudònko*. He asks the Jibaji* Peasants Union to propose an efficient water resource management model that complies with international standards and the agreements signed with the principal investor and the government of Jamanie*. 5% of the dam's profits will be used to implement this new local management model.

3- The President of the Republic of Jibaji* decides to build a multi-purpose dam. 50% of the energy produced will be consumed by companies in the regions along the river and the other 50% will serve to facilitate the development of a bold modern agriculture project. He also intends to offer Jamanie* highly advantageous terms to establish trade for the goods produced as a result of the dam.

4- The President of the Republic of Jibaji* wishes to establish a more friendly relationship with the Jibaji* Peasants Union, beginning with resolving the question of compensation for the dispossessed populations. To that end, he would like 10% of the profits generated by the new dam to be used to compensate the people displaced by the dam or by the old dam built 10 years ago.

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CASE STUDY – SCIENCE ADVICE WORKSHOP

KASSEMBLÉ

Integrating traditional techniques into curricula to address unemployment and poverty

Timpoko Hélène Kiénon-Kaboré, Brïte Pauchet and Rémi Quirion



KASSEMBLÉ

Integrating traditional techniques into curricula to address unemployment and poverty

Note: The elements presented in this case study are fictitious and must not be interpreted as real people, locations or events.

Background

Kassemblé is a country in sub-Saharan Africa. Its gross domestic product per capita totals US\$470, and its particularly young population has a median age of 25 years old. Kassemblé's wealth is driven by cotton, coffee and cacao exports. Citizens rely on items derived from their traditional knowledge: jewelry, bags, baskets and ceramics. A number of constructions, including official government buildings, incorporate techniques and elements from the nation's traditional architecture. Kassemblé supports a number of artisan cooperatives to foster tourism and sustainable development.

Since it declared its independence 60 years ago, Kassemblé has focused on education. Elementary and high school education is free. There is at least one university in each of the country's five major cities. The enrolment rate is therefore high: 80% at the elementary level, including rural areas, 70% in high school and 60% in university. Still, despite their university education, young people struggle to find proper employment. The economic structure is not diverse enough to enable the creation of value-added jobs in services or industry. Deemed to be too theory oriented, the academic programs do not adequately prepare students to enter the job market. In Kassemblé, the unemployment rate is 20% overall and 50% in people under the age of 30. Young people are therefore often underemployed and hold precarious, undeclared and underpaying jobs, making it difficult for them to start family.

Once recognized for the quality of its fabrics, Kassemblé is struggling to develop a sustainable textile industry. It remains the region's largest cotton producer and continues to export cotton and import low-priced garments and textiles. For several years, global corporation SOTEX has been manufacturing clothing featuring traditional regional motifs worn in Kassemblé. It has been seeking to enter into an exclusive partnership to market its products across the country. Groups in northern Kassemblé that have been using the motifs for thousands of years are very concerned about the impending partnership. Indeed, among the measures implemented to curb unemployment is a pilot project involving the History of Textile Techniques Laboratory at the University of Sountongo and local artisans. Together, they aim to develop a production cooperative extending from the rural areas that produce raw materials to the urban centres in which the processing industries are established.

The prime minister of Kassemblé has made actions to reduce unemployment his key focus and is working to establish large-scale policies involving a number of government departments to stabilize economic growth and lower the unemployment rate. He turns to you, his scientific advisor, for advice on the current situation and initiatives to lower unemployment rates.

Discussion

- Ability to access knowledge and compelling data
 - What are the needs of the council of ministers in terms of knowledge and data in the short, medium and long terms?
 - How will you position your role as a scientific advisor with regard to those of research departments and international organizations? Of other government departments? How will you use their data?
 - What support could allies in neighbouring countries provide? (similar cases, comparative studies, advice on best practices, etc.)
- Multidisciplinary scientific advice and advice outside your field of expertise
 - Because you do not possess sufficient expertise in this particular area, who will you work with? How will you select these resources? What status will they have? How can you maintain your credibility and remain at the interface between the council and the scientific community?
 - What challenges will you face when processing knowledge from a number of disciplines?
 - What are the key phases in your work plan to formulate your opinion?
- Gender and social acceptability
 - What perspectives should be accounted for to foster the use of traditional techniques in the enterprise economy?
 - What challenges does or could Kasemblé face as it develops a productive economy driven by ancestral practices? What are the ways to support this evolution?

Photo: Loom ([Pixabay](#))



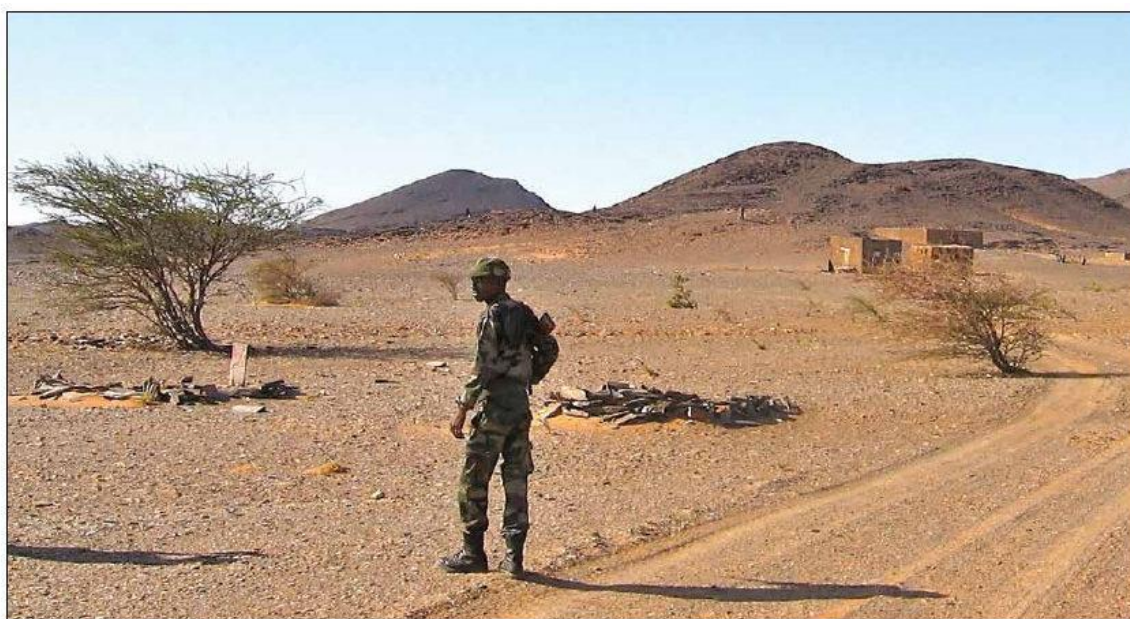
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CASE STUDY – SCIENCE ADVICE WORKSHOP

MIDGAZE

Armed rebellion and reintegration of ex-combatants

Madiagne Diallo, Ag Arya Moussa, Brïte Pauchet and Rémi Quirion



MIDGAZE

Armed rebellion and reintegration of ex-combatants

Note: The elements presented in this case study are fictitious and must not be interpreted as real people, locations or events.

Background

A largely desert nation, Midgaze extends over one million km². It is home to 25 million people, whose median age is 23 years old and who live mostly in the south, in a savannah and forest zone. Two million members of sedentary and nomadic peoples also live in the semi-desert and vast desert regions of northern Midgaze. The desert constitutes a natural border with neighbouring countries. Because state involvement can be arbitrary, opposition groups tend to develop in the area.

In recent years, Midgaze has been diversifying its economy by exporting cotton, sugar, precious metals and rare earths. Despite the inflow of foreign currency, GDP per capita remains at a standstill, never exceeding \$700/year. Some 80% of Midgazians continue to rely on crops and livestock on agricultural land that mainly lies to the south. The livestock farmers are generally members of nomadic groups that depend on rainfall to feed their animals. Over the past few years, climate change has led to an increase in droughts. In the most affected northern areas, the impacts of the droughts give rise to clashes between the sedentary farmers and nomadic herders.

The nation's economic development is especially felt in the south, near the capital. The populations in the desert and semi-desert northern areas feel ignored and pushed to the sidelines of life in Midgaze. Indeed, compared to the south, quality jobs are rare and unemployment is higher, especially among young people. Infrastructures are outdated or inexistent. In addition, successive droughts have depleted the land, syphoned the water table and killed livestock. Hostility against the government simmers, to the benefit of a number of armed groups that engage in abuses and abductions on roads. As the region becomes increasingly unsafe, some farmers have chosen to take up arms against the criminals.

In neighbouring countries, which are equally unstable, young people are joining radical movements that provide the livelihood activities and relative security that governments seem unable to ensure. Five years ago, Midgaze led a military campaign in the northern regions to quell an emerging coup—an intervention that did not have the unanimous backing of the population and was rather seen as a means to muzzle the opposition. From major southern cities to northern villages, young people openly criticized the operation. Since then, several isolated incidents in Midgaze bear witness to an emerging radicalization, including the arrest of young people seeking to join armed groups and a religious leader with presumed ties to the radicals.

The government of Midgaze is facing armed rebellion in the north. The populations have lost faith in the country's ability to keep them safe, revolting and erecting barricades to defend their farms and

villages. What is more, several armed groups are crossing the region, setting up roadblocks to steal goods and seek ransoms from merchants and villagers and raiding unprotected villages. Finally, a group of religious extremists has moved into the area to capitalize on the instability, attracting growing numbers of young people from Midgaze and neighbouring countries with promises of better lives.

Issue

Under national and international pressure, the government is seeking to resolve the situation. Amid growing dissatisfaction in the north and south, citizens are looking for ways to support their families. Rumours are circulating and calling into question the aging president's reputation as a wise reconciler. The countries in the sub-region are accusing the Midgazan government of being soft in the face of violent extremism. In response to the criticism, the president intends to announce a series of concrete measures to stabilize northern areas and demonstrate to all that Midgaze is and always has been an example of peace and harmony in the region. He mandates his minister of the armed forces and public security to negotiate a plan to exit the crisis with the various factions and his minister of employment and social solidarity to set out a three-year action plan to reintegrate ex-combatants into civil society.

To secure the zone and its access routes, the army sets up control posts along the main roads and plans to establish an additional post near a community forest. The project is not well received by the population, since it prevents villagers from reaching the area where they harvest tekri, a plant with known medicinal virtues from which they draw an income

To finalize its plan to support the reintegration of former combatants, the minister of employment and social solidarity calls a meeting of experts from a range of fields: education, political science, sociology, psychology and economics. Their plan hinges on several strategies: training, education on civic-mindedness and wealth creation. While the proposals garner positive feedback from the public and academia, they are disputed by northern Midgazan communities. Mediators report that citizens feel doubly prejudiced since the financial resources support only thieves and combatants. Community workers and psychologists in whom the communities trust affirm that idleness and drug consumption run rampant among young people. A number of stakeholders, including international experts, are of the opinion that the ministry's plan is not ambitious enough and should also account for economic revitalization across northern Midgaze. For the plan to be effective, it must account for the claims voiced by local communities and their need for reparation.

Tensions rise as the date of the signing of the peace agreement between the Midgazan government and armed groups approaches. Knowing that the president wants the process to be successful, the minister of employment and social solidarity assembles a panel of experts led by her senior science advisor to assess current scientific knowledge on armed conflict management, ex-combatant reintegration, the risk of trauma exacerbation and risk perception.

Photo credit: Soldier on duty in the Sahara Desert ([United States Department of State](#))



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Mulikamée¹: a fictitious case study

Fighting unemployment, emigration and radicalization

Resource person: Aminata Sall Diallo, Technical Advisor, Ministre de l'Enseignement Supérieur et de la Recherche, in charge of Research and Cooperation.

Mulikamée is a predominantly Muslim country in West Africa. Its population is extremely young, with an average age of 22 years. While the country's economic situation is promising, growth rates vary considerably from one year to the next: they are dependent on the vagaries of the weather, which influence agricultural productivity and fishing.

Data produced by the Mulikamée Institute of Statistics indicate an unemployment rate of 10%. Although this rate is comparable to that of many European countries, in the streets, the reality is quite different. Many young people find themselves under-employed in the so-called "informal" sector; they work on farms or engage in undeclared small scale commercial activities that prove to be highly unprofitable. These young people in precarious situations are not officially counted as unemployed and feel marginalized and excluded.

According to a World Bank report, with the country's youth to drive the workforce, Mulikamée could well achieve emerging country status within the next twenty years. In order for this to happen, policy-makers must deal with the issue of employment for young people who, more than ever, are aspiring to better living conditions. Some youth are turning away from government solutions, choosing to follow alternative paths such as violent radicalization and emigration.

The government is not succeeding in reducing illegal emigration from the country. "Leave or die" is the leitmotiv of the young people who decide to illegally enter the Schengen Area, embarking on makeshift boats bound for Spain. Smugglers, tempted by the lure of profit, paint an excessively idyllic picture of the conditions that await them upon their arrival. Despite the ships patrolling the waters in collaboration with the European Union, hundreds of Mulikamenes undertake this extremely hazardous crossing every week. Spectacular shipwrecks kill thousands of migrants each year, feeding the media with touching stories of orphaned families who are referred to as victims of a failing economic system.

In its more politically unstable neighbouring countries, many young people are joining radical movements, which offer them subsistence and relative security that the State seems unable to

¹ Mulikamu is the main character in an African folktale. Mulikamu was called on by the great sage Mguri-Mgori to make his people understand the value of work.

provide. Five years ago, Mulikamée came to the military aid of Samirie when radical groups staged a *coup d'état*. This intervention did not have unanimous support: a minority of Mulikamenes, most of them young people from the suburbs of large cities, openly criticized the operation in the media. Over the last three years, a number of isolated incidents across the country have attested to the emergence of radicalization: arrests of young people preparing to join armed groups, the arrest of an imam for alleged links to the movement, etc. However, the majority of Mulikamenes perceive their country as a safe haven, and do not really worry about the development of terrorist cells on their territory. Many believe that the historically peaceful Sufi religious communities constitute a bulwark against religious radicalism.

When it comes to education, while remarkable progress is being made in providing access to primary education, there is an acute need for vocational training. Curricula are considered too theoretical and do not adequately prepare young people to enter the labour market. Existing vocational training institutes are not able to accommodate all of the young people who wish to acquire more practical skills, especially in rural areas.

Seeking to better understand how her government can fight poverty in a sustainable way, the President of Mulikamée commissioned a report from a major international research firm. This report provided interesting economic insights, but little data on social issues around youth unemployment. She then turned to non-governmental organizations and her Ministry of the Interior for additional reports. These reports showed that, in rural areas, close to half of all unemployed youth are family helpers, meaning that they contribute to the family business in exchange for room and board and have no appropriate vocational training. In the cities, young graduates are particularly affected by unemployment. One of the main reasons for this is that, despite good economic growth, the structure of the economy has not changed to facilitate the creation of value-added jobs in service or industry. Young graduates are thus tempted to emigrate to countries that will offer them job prospects commensurate with their qualifications.

The President of Mulikamée made the fight against poverty the primary focus of her seven-year mandate. She is seeking to establish a wide-ranging policy involving various ministries (Education, Youth, Homeland Security, Economy, Science, etc.), whose main objectives are to stabilize economic growth and lower the unemployment rate. She is concerned by the rise in radicalization and illegal emigration and understands that youth unemployment could be the cause. Despite the studies, there appear to be a range of possible responses and the policy options need to be refined. Furthermore, she is alarmed by the significant disparities between the figures produced by the Mulikamée Institute of Statistics, the Ministry of the Interior and the research firm.

The President of Mulikamée now turns to you. You were recently appointed as her scientific advisor. You have experience in forestry engineering and management, and have a PhD in geography and environmental science from the University of Mulikamée. **She asks you to deliver, in six months' time, a report presenting the state of knowledge on unemployment, emigration and radicalization in Mulikamée, along with possible solutions. You will need to**

use a multidisciplinary approach that takes you outside your field of expertise. How will you proceed to prepare this report and what will be its main points?

Mulikamée: a fictitious case study

Group exercises

DISCUSSION

Capacity to access knowledge and evidence

- What are the knowledge and data needs of the Office of the President, on the short, medium and long term? In your opinion, why did the research firm, the Institute of Statistics and the international organizations fail to produce a satisfactory response?
- How do you position your work as a scientific advisor in relation to that of the research firms and international organizations? And in relation to other ministries? How do you use their data?
- What do you think of the means employed by the Office of the President to access the necessary data and knowledge? What would you recommend in that regard?

Multidisciplinary scientific advice outside your field of expertise

- As you do not have sufficient expertise, what type of resource persons will you work with? How will you select them? What status will you give them? How will you maintain your credibility and remain the liaison between the Office of the President and the scientific community?
- What challenges will you face when dealing with knowledge from multiple disciplines?
- What will be the major steps in your work plan in order to produce the report within the given time frame?

Communicating interrelated social issues

- To what extent can we affirm that unemployment, emigration and radicalization are interrelated phenomena?
- How will you express the complexity of the relationship between these phenomena and the resulting uncertainty? What false expectations do you risk creating and how can you avoid them?
- How can you communicate this interrelationship, in order for policy-makers to adopt a comprehensive strategy? What are the main challenges that the Chair will have to meet in establishing a comprehensive strategy?
- What are the cultural aspects of this dossier? How will policy-makers take into account the culture and religion of Mulikamenes? How will you take them into account in your work as a scientific advisor?

ROLE PLAYING

Each table is given a role. The table has 15 minutes to designate the participant who will embody the role during the plenary session and to prepare some content, in regard of the previous discussions.

- Four science advisors (two for the first role play, two for the second one)
- One President
- Some experts (designated directly during plenary session)

First role play: assembling an expert committee

The two science advisors will propose, in turns, experts to form a committee on the issue of youth unemployment. People among participants will be designated to play the role of these experts. The science advisors discuss with them to explain their mandates, their working conditions (short delays, cross-sectoral collaboration, etc.) Shall the experts accept these conditions?

Second role play: President briefing for an interview

The President has an interview in 30 minutes concerning the government's actions to fight youth unemployment. She asks her two science advisors to give her some key information and last-minute advice. What information should the advisers present, and how? What should be the specific demands of the president?

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INGSA WORKSHOP MATERIALS

NICOTERIA:

E-cigarettes as a public health strategy

Writing team: Kristiann Allen, Peter Gluckman and James Wilsdon



VARIOUS TYPES OF E-CIGARETTES

NICOTERIA:

E-cigarettes as a public health strategy

Note: materials in this case are fictional and should not be taken to represent real-life people, places or events.

Nicoteria is a rapidly developing country in Africa. It has a population of 65 million and a GDP per capita of US\$4950 and is rising at a rate of about 7% per annum. The country is rapidly urbanising and the impact of foreign culture is particularly evident among young urban men and women. Smoking rates are rising rapidly such that 17% of urban Nicoterians between the ages of 15 and 25 smoke cigarettes (double that of ten years ago) and rates are even higher among 25-40 year olds. A major multinational tobacco company (Atlantic Tobacco Company or ATC) has a long established presence in Nicoteria, with tobacco production a significant contributor to the national Nicoterian economy. ATC is the dominant producer of cigarettes sold in Nicoteria and neighbouring countries as well as an industry leader internationally. ATC has stated in its public shareholder briefings that, with declining tobacco usage in other parts of the world, they see promise in a massively expanded market in Africa.

Background and context

Within the UN Sustainable Development Goals framework (Goal #3), the WHO, UNDP, African leaders and health officials are demonstrating increasing concern and leadership about the rising rates of respiratory illness, heart disease and lung cancer in Sub-Saharan Africa. Heart disease is now the single largest cause of death in Nicoteria. Smoking has been controlled in all publicly administered buildings, beginning with airports, schools and hospitals, but smoking rates continue to rise. Some attempts at smoking cessation campaigns have been made using social media, but these have had little impact.

A visiting professor to Nicoteria's leading Medical School from a major European University has suggested to the Minister of Health that the introduction of electronic cigarettes would be beneficial as a harm reduction strategy. She points to a well-known study from the UK that suggests that e-cigarettes are a successful way to stop smoking. Use of e-cigarettes would allow individuals to address and taper their nicotine addiction while immediately reducing their exposure to harmful tars. At the same time however, a visiting US professor at the medical school opposes the introduction of e-cigarettes, pointing to a USA study that points to e-cigarettes as a 'gateway' to conventional smoking in that teenagers who start smoking with e-cigarettes will soon move to ordinary cigarettes. The local office of an international health NGO working among urban Nicoterian youth argues that the long-term safety of e-cigarettes is unproven – particularly as the filament can release heavy metals that can be inhaled. In any case, they say, the higher-end electronic devices are out of reach financially to the target demographic.

Recently a local start-up called "BreakFree" has designed a prototype e-cigarette device specifically for the African market, which is aimed at affordability and safety (by allegedly lowering exposures to heavy-metals and other toxins). BreakFree has secured some notable Nicoterian investors and politically powerful philanthropists to support their research and development phase. With these well-

placed connections, BreakFree is also pressuring the Nicoterian Ministry of Health to approve its product for sale to the public. BreakFree has teamed up with another Nicoterian company - a manufacturer of generic medicines – to produce the liquid nicotine capsules for the devices. They have also enlisted the help of a group of researchers at Nicoterian national university, both to develop new varieties of capsules as well as to help build the public health case for their product..

The dilemma

ATC, which is a major contributor to Nicoterian GDP, is opposing the licensing of the locally-made e-cigarette. Despite having diversified their own product lines to include a highly successful (though expensive) range of electronic cigarettes for the European market, it is clear that the company sees Africa as the key (and growing) market for its traditional product – conventional cigarettes. The head of the company's African division is strongly hinting to Nicoterian government officials that approval of the domestic e-cigarette would lead to the company reducing its tobacco plantation and processing facilities in Nicoteria and expanding these operations instead in neighbouring country. At the same time, the company has undertaken its own research about what it is calling 'artisanal' e-cigarette devices. Further, a not-so-subtle plot about the apparent 'dangers' (heavy metals, no filters, improper mixtures) of these cheap and unregulated devices has appeared in a popular television drama that the tobacco company sponsors.



The role of scientific advice

The Nicoterian Academy of Science (NAS) has been asked to give advice to Cabinet on the safety and use of e-cigarettes and whether locally made electronic devices are less safe than the range of available devices produced by ATC. They wish to know whether the NAS thinks they should license the introduction of e-cigarettes and under what conditions. What considerations should be taken into account in preparing the Academy's report?

GROUP EXERCISES

Exercise 1: Group discussion

What issues does the National Academy need to consider in preparing response?

- Communication of complex science
 - Who are all the stake-holders?
 - How to get to the various groups?
 - How to handle media and other channels of communication?
- How secure is the evidence?
 - Is there a difference between government-led science and science undertaken by the academy and that provided by companies?
 - What are the elements of knowledge brokerage that come into play?
 - What we know
 - What we do not know
 - Risks of action or inaction
 - Alternate approaches
 - Trade-offs
- Science advice vs. advocacy
 - The evidence of adverse health effects due to smoking is well documented. So too are the epidemiological data on rising rates of smoking among young people in Africa. What role (if any) does a science advisor play in building the case for government support for e-cigarettes?
 - To what extent should science advice argue for a particular public health intervention over any other, to a recognised public health concern? How should science advice treat the options?
- Issue of social license
 - Is the science stronger or more uncertain for one public health intervention option or the other? What considerations are there about the extent of uncertainty?
 - How should the Academy's committee deal with the research that is being promoted by the tobacco company through popular culture (TV and radio programmes)?
- Other considerations?
-

Exercise 2: Role-playing

Listed in no particular order, the following perspectives (participants may identify others) have been outlined for use in a role playing exercise. Participants are divided into groups and encouraged to both consider the perspective of various actors as listed, but also what the science advisor or advisory body might do in each situation.

Perspective 1: National Academy

- What perspectives and considerations should be reflected in any advice given?
- What is the role of the national academy?
- What might be the limits to the academy's role in this case?

Perspective 2: Media

- The national current affairs programme wishes to host a debate about e-cigarettes as a public health harm reduction intervention. They have invited the visiting UK and US professor who hold opposing views on the matter, as well as Chair of the National Academy. What might be the key considerations for the Chair in this debate?
- How should differing scientific views best be explained to the public?

Perspective 3: BreakFree (local e-cigarette producer)

- You are the director of government relations at the small start-up company "BreakFree", which produces an affordable e-cigarette aimed at the young African market. Your organisation has engaged local scientists to review the available public health evidence about the impacts of e-cigarettes and 'advise on the advice'. What would you consider a fair and robust public discussion?
- What would the science advisor consider a fair and robust discussion in this regard? How could this be achieved?

Perspective 4: Big Tobacco Company

- The regional representative for the Tobacco Company has submitted the company's own research for consideration by the National Academy's expert panel and has requested a meeting with the panel. How could this be handled?
- What might the science advisory panel consider a fair and robust discussion with the representative and vice versa?

Perspective 5: Public Health Officials

- You are the medical officer within the Nicoteria ministry of public health. What would you hope to get out of the expert panel report? What additional considerations might you bring to their deliberations about the relative merits of e-cigarettes as a harm reduction approach and/or about approaches to smoking cessation? How will you incorporate the panel's findings and recommendations into your work?

Perspective 5: Politicians

- As Prime Minister you have received the advice and followed the media reports (and social media) on the issue. How are you incorporating science into your thinking? How does science advice figure among the various considerations in your decision-making?
- How should the Academy's expert committee best deliver advice to the Prime Minister of Nicoteria?

Other perspectives?

Exercise 3: Some further considerations for discussion:

- What are the trade-offs of licensing the locally developed e-cigarette or not licensing it?
- To what extent is the science advisor/advisory body also an advocate for one option or another where the public health evidence is strong?
- What constitutes sufficient evidence about the impacts of e-cigarettes?
- Should distinctions between different types of e-cigarettes be taken into account when assessing the evidence?
- What do we know about what is working or not working in existing smoking cessation interventions and public health campaigns?
- Are there ethical considerations regarding harm reduction approaches?
- What are the considerations in filling positions on the Academy's expert advisory committee for this project?
- What is the role of science advice in decisions affecting the national economy?

PHOTO CREDITS

COVER: Various types of e-cigarettes. Credit: www.ecigclick.co.uk, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=44921909>

PAGE 3: Parts of an electronic cigarette, public domain.

INGSA CASE STUDIES

NJAGALA: YOUTH AND SOCIAL MEDIA

Written by the INGS Africa Steering Committee 2019



NJAGALA

YOUTH AND SOCIAL MEDIA

Background and context

Njagala is a middle-income country in sub-Saharan Africa with an estimated population of 50 million people and GNI per capita of US\$ 3000. The average age of its population is 15.5 years. Its major sources of income are agriculture (bananas and cocoa), mining (diamonds and copper), and tourism (safaris). There is a fast growing IT industry as well with the recent introduction of mobile communication and digital TV in the country. It is a landlocked country that enjoys friendly diplomatic relations with its neighbours, especially those with sea ports.

A recent World Bank study found that over 90% of those who graduated from Njagala's universities with first degrees were unemployed in any of its formal sectors. However, online betting, get-rich-quick schemes, and untaxed online trading were thriving areas of the informal economy that absorbed most of these graduates and other young people. Given that over 95% of the population in Njagala owns a smartphone and that data to access the internet is cheap, most of this kind of trading occurs over social media platforms.

Additionally, there is a presidential and parliamentary election scheduled for September 2019 to choose a new president and members of parliament. The current president, who has ruled the country for the last 32 years and overseen its transition from a low-income country to a lower middle-income country, is aware that his sole opponent is using these same social media platforms to launch an effective campaign against him. That campaign is touching the youthful population in unprecedented way, leading to high youth participation in this and other political processes that had largely been left to older people in the past.

Moreover, with this access to social media, some online schools have opened in the country in order to teach those who cannot afford to physically attend university. These online universities operate with licenses issued in other countries that allow for such education models. Njagala does not issue licenses to online academic institutions although its laws are silent on the validity of academic credentials acquired from online academic institutions. In fact, many cabinet members have earned their advanced degrees from these very institutions and see no reason to revisit that law. Many of those graduating from these online institutions are seen as better placed to take on jobs in the growing IT sector. Those graduates are also challenging other candidates for positions in other practical fields such as agriculture and mining because the online education requires them to complete some practical field work before they are granted their degrees. This practical aspect is not required in Njagala's universities since graduates have always been able to learn on the job after graduation. That education model is now being challenged.

The dilemma

The Government: The President has instituted a 20% Over The Top (OTT) tax on those using social media platforms effective immediately. Other uses of the internet (e.g. email) are not

subject to this tax. The stated reason for this new tax is to increase the amount of domestic tax collected in the country so that it can be invested in the education sector. This move has been welcomed by many business leaders whose market share has been undermined by the informal online trading via social media.

Recent Graduates: A section of vocal recent graduates of Njagala's universities has lodged a legal case against the government for not safeguarding the few jobs available to them upon graduation. They assert that government's silence on the validity of online credentials undermines their ability to get gainful employment in their own country after undertaking the rigorous undergraduate training in their own country's institutions.

Informal Business Leaders: These leaders, who claim to employ the majority of the country's youth, have called upon the government to revisit its position. They have also called upon the population to boycott OTT tax and those businesses that support the government's position. Initially thought of as a publicity stand by the government, the influence of these informal business leaders has been felt in the formal sector as detailed in their projected losses for this fiscal year. Those losses have been attributed to a drastic fall in domestic sales.

The Moralists: There is a powerful lobby that wants to maintain the purity and uprightness of the youth. This group wants all social media platforms to be banned in the country. They claim that beyond betting, social media also promoted prostitution, pornography, the spread of misinformation, and promotes laziness since the youth spend more time on their phones than in other areas.

The Opposition: The opposition candidate and his allies claim that the government's recent move will only last until the end of the election since the youth are now effectively cut off from the political process. All other claims about morality and developing education in the country are fabrications of the government to further disempower the youth.

The Economists: These learned members of the society claim that the economy will suffer dearly in the coming months because of the lost revenue in the formal sector combined with the loss in revenue generated by all the trade in the informal economy. As informal is it is, the production in the informal economy generates income that is channeled back into the formal economy (e.g. through the purchase of airtime and data from cellular companies).

With increasing international attention on Njagala, the negative impact of prolonged legal processes, and credible reports of planned mass protests across the country due to this situation, the President has called upon his independent science advisors to present a viable way forward backed by credible evidence so that his government can formulate a policy to address this matter.

The role of scientific advice

The President has managed to secure an agreement from all the conflicting parties to give one month to these science advisors to formulate their advice. The following questions must be answered in that time:

1. What ethical and moral considerations should be taken into account if a country chooses to allow the use of social media within its borders?

2. How much misinformation is spread through social media and how can that practice be curbed?
3. What are the economic benefits of social media to Njagala?
4. What is the value—in theory and practice—of online education within the context of our country?
5. What legal and regulatory aspects must our country take into consideration with regard to social media?

How should the science advisors go about assembling sound evidence to answer these questions within the timeframe given? You have budget constraints and the number of scientists willing to give vital testimonies to help address these questions are few given the charged political situation in the country.

QUESTIONS FOR REFLECTION

1. What principles and guidelines of science advice should be applied in considering this case?
2. What issues should the scientists consider in preparing a report for the President?
3. What perspectives and considerations should be reflected in any advice given? (including steps taken to build evidence)
4. What is the role of the national academy, the science advisor, research institutes, think tanks, civil society, lobbyists, and other interest groups?
5. What might be the limits to the science advisors' role in this case?

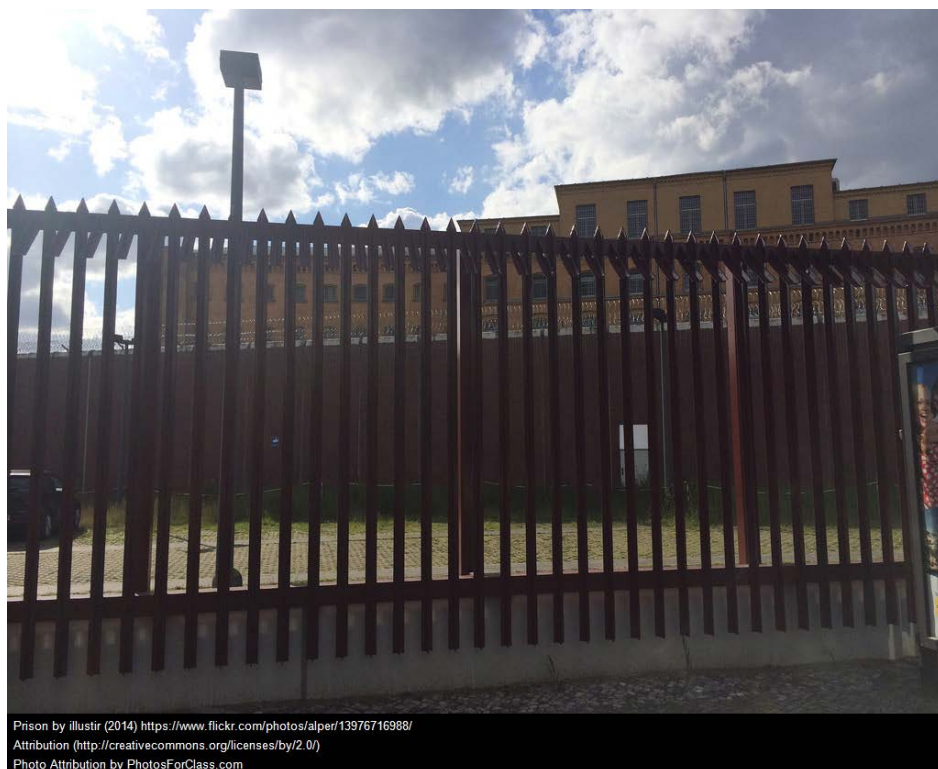


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INGSA CASE STUDIES

ORANGERIA: MOBILIZING SOCIAL SCIENCE EXPERTISE TO REDUCE CRIME

Tatjana Buklijas (INGSA/University of Auckland)



ORANGERIA

MOBILIZING SOCIAL SCIENCE EXPERTISE TO REDUCE CRIME

Background

Orangeria is an upper middle-income democratic republic. Following a period of recession, it is now experiencing rapid economic growth and it has recently been admitted to the OECD. It is highly ethnically diverse, with 8 spoken languages among its indigenous peoples (making up about 20% of population), a number of ethnic minorities descended from economic and political migrants that had immigrated into Orangeria over the past century and half (further 20%) and the dominant ethnic group that also controls much of the country's wealth. Its inequality is one of the highest in the OECD and it is linked to pronounced health disparities as well as, arguably, high rates of crime. A large part of criminal activity involves drug trafficking and gangs. A reduction of crime is important, not only for internal reasons but also to signal the stability and security to foreign investors.

Dilemma

At last elections, a centre-right party won most votes but could only form government in coalition with one of the minority parties, a centre-left party that is supported by urban, educated Orangerians. One of the key election campaign promises was to "make crime a top priority". This promise was incorporated in the well-publicized campaign manifesto which included hardening of bail laws so that custodial remand is much more likely than in the past when bail would be given. The manifesto also included the introduction of longer prison sentences. However, the result has been an increase in prison populations, more incidents of violence in prisons and prison overcrowding, leading to a pressure to build new prisons. Orangeria's underprivileged indigenous and minority youth are overrepresented in the prison population already and this percentage has grown since the new policies were enacted. The main newspaper in the capital, *Orangeria Post*, has been running a series of investigatory pieces pointing the rising number of young adult males now in prison. This is now causing considerable political angst amongst centrists.

The Minister of Finance is arguing within Cabinet that the problem will not be solved by building more prisons and that the funds would be better spent on other areas, such as education and services for youth. The Minister of Justice, who created the plan, is adamant the 'tough on crime' policy is correct. The centre-left coalition partner had been uncomfortable from the start with the approach that the government had taken and has sided with the Minister of Finance, calling for the

policy to be reconsidered. They had been given the Ministries of Education, Social Services and Indigenous Affairs and are of opinion that inclusive educational programmes offer better potential for positive outcomes for those most likely to join gangs. While the President supports the Minister of Justice's plan, she is open to changes in policy as long as they give credibility to her party's commitment to reducing the crime rate.

To complicate the matter further, expert opinion is also sharply divided. A highly respected academic psychologist has argued that the problem starts in childhood and is better addressed through early childhood and primary school education. Public health experts follow a related line of thought, arguing that at least some of the funding spent on prisons should be directed into early intervention programmes. These programmes could discover families in need of help, prevent (or at least mitigate) child neglect and abuse, improve parenting skills, diagnose children in need of special assistance, health or educational support. In the long run, such interventions should help to prevent crime. Others argue the problem is one of mental health and drug addiction and money should be spent on that. Another psychologist associated with a right wing think tank argues young people need more discipline and conscription should be reintroduced.

An academic sociologist highlights the disproportionate representation of the indigenous peoples in prisons. She argues that this reflects the structural racism of the Orangerian society. Her argument links with the highly publicized work of an anthropologist working with Orangeria's indigenous peoples. The latter has suggested that the inability of indigenous men to find their place in a rapidly changing society has led to a lack of self-confidence, with many finding refuge in the gangs. He is suspicious of early intervention programme proposals, saying that these will only lead to a high rate of indigenous children being adopted out of their families. While such adoptions had only happened in isolated cases in Orangeria in the past, he is drawing on the historical evidence from other countries where removal of indigenous children from their families and their formative years spent in often abusive situations and without parental role-models caused a trauma that reverberated for generations. He asserts that a focus on early intervention in the absence of support for the whole family and broader community would exacerbate the problem of identity loss and could potentially lead to an even higher percentage of indigenous young men finding gangs to be a substitute for lost cultural and family affiliation and identity.

The anthropologist's arguments are, in turn, countered by claims that it is poverty and economic inequality, not racism per se, that is at heart of the problem. Those making these claims point out that for several decades the country has implemented a range of initiatives to correct past injustices by establishing programs to revitalise indigenous language and culture, and to settle land and

natural resources claims. These critics are associated with a left wing party that is gaining traction with the public by focusing more alleviating poverty by increasing minimum wage and making the tax code more progressive.

Further expert input comes from a local criminologist from the National University of Orangeria who thinks that the government should focus on the rehabilitation through novel means such as community sentencing and Elders' panels, which have been shown to be successful in other jurisdictions with high offending rates among indigenous youth especially. Yet many in the ruling party believe that is being soft and that the government should maintain a "tough" stance.

It is clear the question of crime is turning into a major problem, possibly destabilizing the current government with the coalition partner openly expressing its disapproval of the current approach. Making the matter more complex, different academic experts have very different views.

The President is becoming overwhelmed with the different types of evidence that the various experts are offering and is under increasing political pressure to act. She asks the science advisor a simple question: Whom should I listen to?

INGSA WORKSHOP MATERIALS

PANDERIA:

Pandemics, panics and international borders

Writing team: Kristiann Allen, Peter Gluckman and James Wilsdon



DOCTOR READS A PATIENT'S CHART

PANDERIA:

Pandemics, panics and international borders

Note: materials in this case are fictional and should not be taken to represent real-life people, places or events.

A new highly infectious disease, labelled African Forest Respiratory Encephalitis (AFRE), is spreading across Western and Central Africa. So far it has claimed 6,500 lives of which 4,000 have been in the country of Panderia. AFRE is thought originally to have been transmitted to people from the now-endangered red-backed forest baboon, and is now spreading through human-to-human transmission. This transmission is happening most likely through droplet spread, as the disease starts with a respiratory infection. Within 24 hours it becomes encephalitis, which is often fatal or which can leave individuals with neurological damage. On social media, #KickoutAFRE is now a rallying cry. People in Africa and outside have created Facebook groups as tools for public awareness and advocacy, posting infographics on AFRE prevention and sharing information. The Centers for Disease Control (CDC) and the World Health Organization (WHO) work with these groups to disseminate as much accurate information as possible.

Background and context

Average fatality rates from AFRE are around 50%, but can vary from 25% to 90%. The mortality rate is higher in women than in men, especially pregnant women. Community engagement is important to controlling outbreaks, through a package of interventions: case management, use of face masks, surveillance and contact tracing, a good laboratory service, safe burial practices and social mobilisation. Early supportive care with rehydration has been shown to improve survival. There is as yet no licensed treatment to neutralise the virus but two candidate vaccines are under development thanks to rapid deployment of international funds and expediting the ethical review processes for human trials.

Efforts to tackle AFRE also have to contend with the power of social media. Claims of cures and panic-inducing conspiracy theories have often followed sudden outbreaks of diseases generally. The conversations about AFRE are no exception. Facebook, Instagram and Twitter are prominent in African cities, but inaccurate information is worse than no information at all. For every social media post pushing accurate information, there seems to be another one about all manner of supposed cures, or rumours that poisoned water, not AFRE, are causing people to die. The social media conversation has become chaotic, with politicians, experts, NGOs and community leaders all trying to be heard. Confusion and rumour have made it harder for health care workers and government officials to combat the outbreak. In Hamudu, a Panderian regional capital, medical staff were chased away by local residents who feared that their infected relatives would be taken away for treatment, but would never return.

The dilemma

The Chief Medical Officer of Panderia is working hard to disseminate accurate information. She acknowledges that: "Lots of people are really scared and not getting proper information about what happens in the treatment centres. They see people going into the hospitals and coming out in body

bags.” Some are turning to traditional healers in a bid to combat the disease through prayers and exorcisms, rather than medical science. Also, unscrupulous merchants are selling “AFRE vaccines” at extortionate rates. These supposed vaccines are made from limes and onions.

Five days ago, a rumour began to circulate on social media that drinking hot water with considerable amounts of added salt could prevent AFRE. Already, excessive salt consumption in the summer heat has led to 38 deaths and 140 hospitalisations in and around the most affected regions of Panderia.

“In situations like these you have two choices”, said the Chief Medical Officer in a widely publicised interview. “You can refute the rumours one at a time or you can try and affect the overall information environment by providing information about the scientific evidence repeatedly.”

She has taken to hosting chats on Twitter, but is also focusing on the more traditional media. Her network of experts, supported by various international agencies, have appeared on local Panderian radio stations, distributed posters and done outreach on AFRE prevention, transmission, and signs and symptoms. Alongside this team, the mayor of Hamudu has now appointed a “rumor manager” to dispel myths about fake cures that are spreading through the city.

The role of scientific advice

You are the chief scientific advisor of Proxeria, a small neighbouring country. It is believed, that the pandemic has not yet reached Proxeria owing to the largely mountainous and forested border between the two countries. Historical tribal differences between the two countries have largely discouraged inter-migration. However a group of more than 40 migrants from Panderia have managed to enter Proxeria at an illegal border crossing. Thirteen of these new arrivals have been found at the central bus station, but others have already secured accommodation with personal connections in the country.

Seven of the Panderian migrants at the bus station now have respiratory symptoms. Mass panic is breaking out and a new hashtag is trending in Proxeria: #KickoutPanderians. You and the Proxerian chief medical officer are called to an emergency meeting of Proxeria’s Cabinet. What are the considerations that you will have to take into account in the discussion?

GROUP EXERCISES

Exercise 1: Group discussion

What issues does the Science Advisor need to consider in preparing response?

- Communication of complex science
 - What are the top messages to Cabinet? How should complexity and uncertainty be communicated?
 - How might messages and communications techniques evolve over the course of the pandemic?
 - What is the role for social sciences in this case? How can insights from social sciences support appropriate communications?
 - How can social media be used to best effect.
- Role of the Chief Scientific Advisor in emergencies
 - How does the urgency of the situation affect the impact and reception of science advice?
 - What are the elements of knowledge brokerage that come into play and how are these affected by the urgent context?
 - What we know
 - What we do not know
 - Risks of action or inaction
 - Alternate approaches
 - Trade-offs
- Cross border considerations
 - How might the international nature of the issue affect the role of the Chief Scientific advisor in this case?
 - What other sectors and stakeholders should be engaged? What is the role of the Science advisor in such engagement?
- Other considerations?

Exercise 2: Role-playing

Listed in no particular order, the following perspectives (participants may identify others) have been outlined for use in a role playing exercise. Participants are divided into groups and encouraged to both consider the perspective of various actors as listed, but also what the science advisor or advisory body might do in each situation.

Perspective 1: Proxeria's Chief Scientific Advisor

- What perspectives and considerations should be reflected in any advice given to? How would you structure your advice?
- To what extent would you reach across the national border and engage with Panderian officials?

- To what extent would you engage with social and traditional media? What are your key messages?
- Are there limits to the science advice (e.g. policy considerations about the legal status of the Panderian's in your country)?

Perspective 2: Government (Panderia and Proxeria)

- Panderian officials, already overwhelmed by the public health emergency in their own country have been contacted to repatriate the illegal Panderians who have crossed the border. How would they handle the request from the neighbouring government? What are the considerations for officials on both sides of the border? What scientific knowledge need might come into play (e.g.: incubation period of the disease, quarantine procedures, respective health management strategies and lessons to share etc).

Perspective 3: International Health community

- You are the UN Resident Representative in Panderia and have been in touch with your counterpart in Proxeria. You are both liaising regularly with your respective government interlocutors. How would you integrate local science advice into your planning of the UN response in the two countries? What are your primary knowledge needs from the Science Advisor (e.g. social science insights, demographic trends and population patterns?)
- How would the science advisor best engage with UN partners?

Other perspectives?

PHOTO CREDITS

COVER: Doctor reads a patient's chart. Credit: Kendra Helmer, USAID, public domain. <http://www.public-domain-image.com>.



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INGSA CASE STUDIES

Pulpinea

Pulpwood crisis: A potential trade-off between biodiversity & the economy



Pulpinea

Pulpwood crisis: A potential trade-off between biodiversity & the economy

Background and context

Pulpinea is a South Asian country with a population of 120 million people. National growth across all sectors has been increasing over the last decade; with an average annual GDP growth above 7%. Life expectancy is 72.3 years; and continues to increase every decade. With increased prosperity, people's buying capacity has also increased; resulting in greater consumption. One of the biggest economic contributor in Pulpinea is the paper-based industry that creates significant number of jobs and products used domestically and exported to neighbouring countries. At present, the Pulpinean paper industry is completely dependent on imported pulp. Pulpinea imports its pulp primarily from its neighbouring country, Moringa. Both these countries are currently in a long-standing maritime dispute over ownership of an island. As a result, the government of Moringa has threatened to stop the export of pulp to Pulpinea which will result in a complete shutdown of the Pulpinea paper industry. This will result in a serious negative impact on the local economy. This is not the first time, Mangrovia has threatened Pulpinea with cutting pulp supply. Thus, the Government of Pulpinea has been trying to find ways to source pulp locally.

The Pulpinean Chemical Industries Corporation (PCIC) is a government-funded organization that manages the industrial sector in the country. In fact, PCIC has played a vital role in the pulp and paper industry in Pulpinea. The biggest pulp and paper industry is the Pulpinea Newsprint Mill (PNM). The mill used to utilize Gewa (*Excoecaria agallocha*) wood from the Pulpinean region of Mangrovia since the 1950s. Mangrovia is the world's largest mangrove forest; 60% of which resides in Pulpinea and 40% in Moringa. The Mangrovia forest is situated on the Southwest coastal areas and it is the largest forest in Pulpinea. The Mangrovia forest is one of the richest biodiversity hotspots in South Asia. It is home to an estimated 425 species of wildlife, including 400 species of birds and mammals, including the endangered national animal and symbol of pride, the Royal Pulpinean Tiger. Mangrove forests are an important breeding ground for many fishes, crabs, prawns and other marine animals, essential for sustaining a viable fishing industry. Mangrovia's mangroves are more diverse than those in tropical Africa and the Americas. The rivers, canals, creeks *etc.* spread across Mangrovia like a net with their innumerable branches. Mangrovia houses a network of 300 large and small rivers that provides a major source of fresh water in Pulpinea. The forest also acts as a buffer to protect the coastline against cyclones, rising sea tides and other hazardous natural events.

In recognition of its rich biodiversity and its ecological importance, UNESCO declared Mangrovia as a world heritage site in 2000. As a result, the supply of Gewa wood was stopped and the Pulpinea Newsprint Mill was shutdown. At its peak production, the mill was able to

produce 40% of the pulp needed by the Pulpinean paper industry. As a result of its shutdown, Pulpinean complete dependence of Moringan pulp continues today.

The coastal areas and offshore islands suffer from flooding and cyclone severely almost every year. In order to protect the coastal and offshore areas from the cyclone, storm surge inundation and salt-water intrusion, mangrove afforestation was initiated along barren shoreline and offshore islands. The initial plantings proved highly successful in protecting and stabilizing the coastal areas, and led to a large-scale mangrove afforestation initiative that was partially funded by the World Bank. To date, approximately 100,000 ha of mangroves have been planted. Local scientists have developed nursery and planting techniques for the major species, while additional species are still being investigated.

The Government of Pulpinea believes that it is important that the coastal plantation efforts not only mitigate loss of lives and property from cyclones and tidal surges, but also generate employment opportunities through the production of wood for consumption. Therefore, commercially important mangrove species, such as Keora (*Sonneratia apetala*), Gewa (*Excoecaria agallocha*), *Avicennia officinalis*, *A. marina*, *A. alba*, *Amoora cucullata*, *Bruguiera sexangula*, *Xylocarpus mekongensis*, *Heritiera fomes*, *Ceriops decandra* and *Nypa fruticans* were planted. Of them, Keora proved to be the most successful one. At present, this plant constitutes about 94.4% of successful mangrove plantations. Keora is now the main species in the coastal region of Pulpinea. These trees are now completely matured. At present this species has no industrial or any other applications. However, as a result of the extensive mono-specific plantations, outbreaks of two major insect pest species have been observed. A Royal Pulpinean Tiger was also killed during one of the recent replantation efforts. The long-term effects of the introduction of these trees on the overall mangrove ecosystem are also unknown.

Based on research by local Pulpinean scientists, wood from the Keora species has been proven to be a very good source of raw material for the pulp industry. Research results show that the pulping behavior of Keora and Gewa are almost similar. Therefore, the utilization of Keora as a pulping raw material can solve the problem of pulp procurement of the Pulpinean paper industry and reduce the dependency of Moringan pulp; allowing the Pulpinean government to take a stronger stand in future diplomatic discussions with the Moringan government. The PCIC has also recently completed a preliminary feasibility study on the production of pulp from imported bamboo chips from another neighbouring country, Kalinga. Pulpinea and Kalinga share very strong diplomatic relationship and will provide another solution to reduce over-dependency on Moringa pulp. However, Pulpinea will need a long-term agreement with the Kalingan government for sustainable and uninterrupted supply of raw materials for the pulp and paper industries in Pulpinea.

Recently, a news portal latched on the story of the killed Royal Pulpinean Tiger and this has resulted in a nation-wide outrage. A couple of international environmental NGOs have also voiced their concerns of the Keora coastal plantation efforts and have suggested that extensive research needs to be conducted before further afforestation efforts are continued. They claim that more efforts should be done to encourage paper recycling and reduction of consumption. They threaten to lobby the UNESCO to revoke its recognition as a world heritage site.

The prime minister of Pulpinea is feeling under immense pressure and asks you, as his Science Advisor to advise him on what should the Pulpinean government do; with regards to developing a strategic plan that protects the biodiversity of Mangrovia while also securing the Pulpinean economy.

What considerations do you need to bear in mind in doing so? Note: this question is not only about making a specific recommendation but rather about the process and considerations in doing so.



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INGSA CASE STUDIES

***RAWHITIA:
HEALING PSYCHOLOGICAL TRAUMA AFTER CIVIL WAR THROUGH
EDUCATION***

Tatjana Buklijas (INGSA/University of Auckland)



RAWHITIA

HEALING PSYCHOLOGICAL TRAUMA AFTER CIVIL WAR THROUGH EDUCATION

Context and background

Rawhitia is a multi-ethnic, developing African country with the largest ethnic group, Majoritans, comprising 45% of population, followed by Minoritans (30%), Microritans (20%) and a small number of other minorities. In 1961, at the height of decolonization, the former European colony of Rawhitia (formed in the 1880s out of several smaller Majoritan and Minoritan kingdoms) declared independence. At that time, domestic institutions were weak and few Rawhitians had had tertiary education – those that had been educated in Europe were almost entirely Majoritans. While tensions between ethnic groups were present even then—exacerbated by the governing practices of the colonial power which clearly favoured one group —the growing economy, largely based on Rawhitia’s rich natural resources, and optimistic public sentiment in the aftermath of decolonization ensured a long period of relative peace. However, a decade ago the decreasing demand for some of Rawhitia’s main agricultural exports affected its economy, causing high inflation and high unemployment. In an environment of regional political instability and an economic slump, domestic tensions started to rise at the same time as the governance weakened. The political consensus that had allowed for multi-ethnic government at the time of independence started to fracture. The Prime Minister (a Majoritan) and Deputy Prime Minister (a Microritan) fundamentally disagreed on the organization of the economic activity, with the Deputy PM arguing for a stronger role of the state and PM for the liberalization of the market. The Deputy Prime Minister resigned, and soon afterwards the national consensus was replaced by ethnic political parties.

The balkanization of the political scene created a fertile soil for the ethnic tensions to exacerbate. Young men, many unemployed, formed into ethnic gangs and started to inflict harm on other ethnicities. At first this was minor in nature (theft, graffiti, taunting) but it soon led to skirmishes. The murder of a senior Microritan religious leader in one of these skirmishes was the spark that started the civil war, fuelled by ethnic political parties seeking to win votes in the political vacuum. The Rawhitian national army sided with Majoritans, as the officers had traditionally been recruited from that ethnicity. Those not involved in the mutiny, created militias to support their own ethnic parties. Soon Minoritans and Microritans declared their own independent territories and established armies. Over the period of four years the war was fought across the whole Rawhitia. Minoritans and Microritans established an alliance which was initially weak and poorly equipped, but as arms were supplied from another nation with historical and cultural relationships to these

two groups the alliance had grown stronger. Majoritans not only controlled critical resources but also led the internationally recognised government which had the support of international institutions. Effectively the country was now split in three.

Early in the war, the town of Arge, at the eastern borders of Microritan territory, was encircled by the forces of Rawhitian national army. The army's claim was that it was there to guarantee the safety of the Majoritan population in the town (comprising about 30% of population, while 70% were Microritan). The United Nations sent a Protection Force that proclaimed Arge a safe zone. The status quo persisted with both the Rawhitian army and the UN forces camping outside the town, and the town population surviving on meagre supplies provided by the UN. This stalemate lasted for years. But four years into the war, a battalion of the Majoritan army launched an offensive. The UN forces withdrew. Majoritans captured all the Microritan men over the age of 14 in the town (8,000 in total; some were fighting with the Microritan forces out of the city), took them into the forested area outside the town, executed and buried them in a mass grave. In spite of attempts to cover up the crime, reporters attached to the UN discovered it quickly. The discovery led to a change of the prevailing international viewpoint on the resolution of Rawhitian conflict. The three sides were persuaded to cease hostilities, meet and sign an agreement as the foundation of a new political order in Rawhitia, with more political autonomy for Microritans and Minoritans through a federal system of government. The agreement was followed by elections at which a coalition government was elected. The coalition is led by a new party without obvious ethnic affiliation, New Rawhitia which has tripartite leadership involving the President, Prime Minister and Minister of Finance. The key perpetrators of the war crimes have been arrested and are currently being trialled, with the input of international organizations and experts. While there are criticisms of the new political structure and the transitional justice processes and mechanisms, there is an overall agreement that the intentions are good and that this is the only way to maintain peace and rebuild the country.

Problem

Ten years have passed. The town of Arge has become a symbol of a new Rawhitia: a place to show a peaceful coexistence and cooperation can be developed despite the recent history of ethnic conflict. Efforts are ongoing to build bridges between the ethnic groups, initially through various free time community activities: youth camps, art programmes, public celebration of shared holidays, and other voluntary activities. These are visited, but the majority of the population is still reluctant to participate – parents are still wary of their children mixing with the other ethnicities.

The attention is now turning to Arge's schools, seen as sites where a new generation will be raised in the spirit of not only coexistence but also reconciliation and trust, while recognizing and respecting differences. The children are currently divided into separate Microritan and Majoritan programmes, the main difference being that their education starts with their native language and script, although they learn both. Recent events are not taught in schools and, in the absence of new textbooks, Rawhitian history prior to the conflict (including the colonial past) is taught from the old, pre-conflict material. Both Majoritan and Minoritan children receive subtly different views of their past and culture in schools and in their communities and families.

There is a push (by the international community in particular but also by the new coalition government) to establish 'intercultural' schools built on the principles of trust and reconciliation. This project would be supported by a reformed curriculum, which would be used in the whole country, but it would be first rolled out in Arge's intercultural schools.

The national Ministry of Education is now recruiting experts (educationalists, historians, linguists, anthropologists and others) to lead the educational reform. The reform would include the production of new educational material (e.g. history textbooks) as well as the development of a broader approach that would make rebuilding of trust and relationships a central theme permeating all parts of the curriculum. There is support for this initiative in the public and in the academic community, but also a pushback by some experts. Leading historians and linguists, from both ethnic groups, are arguing that they have no independence in their project and that the politicians are telling them what to think about the objects how to do, rather than trusting the experts to do their job.

Within the local community there is a widespread fear that not enough time has passed and that the Microritan children will suffer additional trauma if forced to socialize with Majoritans, some of whom are children of the war criminals. Their fear is supported by psychiatrists and psychologists working with and studying the post-war mental health. Many among the children are suffering from mental health problems caused by the war, siege and loss of family members. The rate of suicide, particularly amongst Microritan adolescents, has been high and is not showing signs of decline. There is widespread substance abuse. A particularly vulnerable group are the children of rape victims from the war, largely Microritans, who are marginalised by most. Their mothers have remained psychologically scarred and socially isolated. A few NGOs have tried to give them support and counselling. The mental health resources are stretched.

At the same time, human rights lawyers as well as a number of educational experts and social psychologists, are strongly advocating the integration of the Arge schools, as well as a broader educational reform. They are stating that, while they accept and understand the reservations of the

families, educational reform is a critical part of a humanitarian response to conflict and an essential part of post-conflict transformation. The longer the wait, they argue, the bigger the obstacle to the integration and the higher the risk of another conflict in future. Rather than waiting for experts to resolve, or narrow, disputes about contested events and questions, they are recommending a pragmatic approach and push for the reform (and new materials) to take place in a timely fashion.

The tensions are growing. Both Majoritan and Microritan veterans' organizations has scheduled marches to coincide with the memorial day of the Arge massacre. The President of Rawhitia, a physician by training, is worried about events that could threaten the fragile peace, yet is also committed to continuing the peace process, building trust and achieving reconciliation. He is asking the Prime Minister to convene an advisory council of scientific experts to help by assessing available scientific evidence regarding the conflict management; risk of exacerbating trauma and also the management of the public perception of the risk.



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**International
Science Council**

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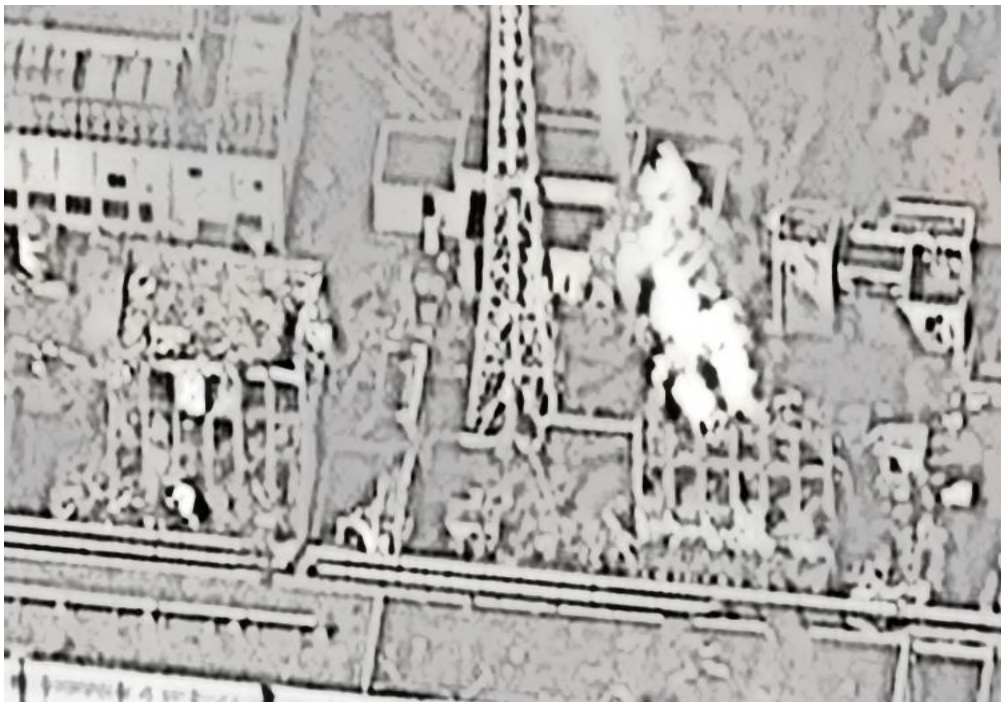


INGSA CASE STUDIES

RESOURCIA:

Powering Change – Immigration, Labour and Social Cohesion in a resource town

INGSA Secretariat; European Commission Joint Resource Centre



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RESOURCIA:

Powering Change – Immigration, Labour and Social Cohesion in a resource town

Background and context

‘Resourcia’ is a federation of six provinces, parliamentary consensus-based democracy and an overall highly developed country with firmly entrenched and widely supported welfare policies, low-level of inequality and high social cohesion. It occupies a large territory and, due to the harsh climate and difficult access across the mountain ranges, parts of the country remain sparsely populated and economically comparatively underdeveloped.

The country is rich in mineral resources, from natural gas to iron ore and uranium. Uranium mines are located in the province of East Resourcia, which was settled in the eighteenth century by a wave of homogenous migration that left the province culturally and linguistically distinct from the rest of Resourcia. Their language remains one of the two official languages in the province (together with the more prevalent Resourcian language) and the traditional cultural ties with the ‘old homeland’ remain strong, with 65% of the population descendant from the original wave of settlers.

In the 1950s and 1960s, uranium mined in East Resourcia was exported for the use in nuclear power plants and in the Cold-War weapons production by a global super-power. In 1982, Resourcia imposed a temporary moratorium on uranium mining in its eastern province, a decision made largely through the public pressure mobilized by a national anti-nuclear lobby group, which would, just a few years later, transform into the Green Party of Resourcia. In 2006 the moratorium was partially lifted to allow restricted exploration with a view to supplementing Resourcia’s own hydro-electric energy production with nuclear-derived electricity and increasing exports.

While the price of uranium has been low over the past decade, the move towards carbon-free energy has made nuclear energy more attractive in some global markets—as part of the mix with hydro, solar and wind energy. Indeed, with the global prices poised to increase again, the Ministry of Energy together with mining companies is looking at lifting the remaining part of the moratorium to allow not only mining but also processing uranium in East Resourcia. However, neither the province nor Resourcia more generally (both of which have low natural population increase and falling numbers of work-active population) have sufficient skilled (or unskilled) workforce.

Conjointly, the federal and the provincial Ministries of Labour and Immigration have launched a new programme that is fast-tracking immigration of migrants with skills suitable for the employment in the East Resourcia mining industry: from skilled labourers to tradespeople and engineers.

The dilemma

Across the globe, the Kingdom of Crossroads is in deep political crisis. Rebels are threatening to overthrow the governing dynasty; while the dynasty, supported by the army, is retaliating by indiscriminate attacks on Northern Crossroads, an identified rebel stronghold.

For over a year the civilian population has been fleeing Northern Crossroads. This mountainous region is a traditional mining territory with rich uranium reserves. However, because of the civil war, the mines have not been operating and the labour force—from unskilled to the highly educated and specialized engineers—are all out of work.

News about the possibility of employment in the newly developing uranium mines and processing facilities of East Resourcia has spread. At least a hundred Crossroaders are applying to the fast-track skilled immigration scheme “Powering East Resourcia”. However their (large) extended families are not eligible for the scheme. The federal Ministry of Labour and Immigration has drafted an additional immigration programme to allow families to reconnect. Yet even before its launch, newspapers critical of the entire plan have begun to publish estimates of the cost, arguing that the cost of ‘unproductive’ family members—healthcare, social benefits, education—will exceed the economic contribution of their ‘productive’ members, immigrating through the fast track scheme.

Furthermore, the Federal right-wing People’s Party of Resourcia is arguing that the immigration of a large number of Crossroaders into the culturally homogenous, and ideologically conservative province of East Resourcia will cause deep social problems. They point to the social science research showing that religious and ethnic diversity reduces social cohesion. The East Resourcia Spirit Party—a political party established to represent the interests of the 65% of the provincial population that is linguistically and culturally distinct—is arguing that any decision by either the federal or provincial governments to settle these “migrants” in the Resourcian heartland of East Resourcia is an attempt to dilute the ethnically and linguistically homogenous population of original settler families in the province, which will eventually lead to the loss of their autonomy and any claims they may have to a form of self-governance. The Spirit Party argues that the money spent to bring and integrate Crossroaders (who traditionally have a higher birth rate than East Resourcians) would be better spent on incentive policies to: increase population growth in Resourcia generally (and especially East Resourcia); to repatriate East Resourcians who emigrated from the province for career opportunities; and to train or retrain East Resourcians for next-generation uranium production.

As the first Crossroader refugee families arrive in the country, protests begin in the capital of East Resourcia. It is less than a year to federal elections and Democratic Party of Resourcia is worried that the scandal will cost them key federal electorates in the province, especially as the People’s Party and East Resourcia Spirit Party have begun discussing coalition at the federal level. They have found an unlikely ally in the Green Party, the former anti-nuclear lobby. The People’s Party is not known for its “green” credentials, indeed they’ve always favoured less regulation and promoted a “business first” position.

The Green Party had fought unsuccessfully against the partial lifting of the temporary moratorium in 2006 and is firmly set against uranium mining, processing and any energy production in Resourcia (which it claims Resourcia does not need). They point out that the environmental damage done by extraction and transportation methods in the 1950s has never been fully remediated. Lakes and entire watersheds around mining sites remain contaminated. The Green Party also bring up the human health costs of uranium mining, caused by radiation as well as inhalation of silica dusts and similar compounds. Finally, they argue that the nuclear energy is not at all carbon-free because much energy is needed to move the rock and process the ore, not to mention dealing with the waste water and other contaminated by-products of the industry.

The governing federal Democratic Party, however, argues that environmental and health regulations, enacted under them, are much stricter than those of half a century ago. They furthermore say that wind and solar power will provide nowhere near enough energy in East Resourcia. To be sure, hydropower does not pollute water or air, but the environmental costs of damming rivers must be taken into account. They also make the argument that East Resourcia has great potential as an exporter of excess energy through its power grid network linked to neighbouring provinces and countries.

The Government is also worried that backtracking on the redevelopment of next-generation uranium mining and the rolling back of the related immigration programme would be seen as a sign of weakness and indecision, leaving room for much political gain by the newly emerging coalition. It could also send a signal to other anti-immigration groups and impact other immigration programmes that the Democratic Party has long supported.

The current scientific advisor to the federal government is from the province of East Resourcia with the background in geology. He comes from a mining family that traces its roots to the early settlers in the province, and was the first one to get a university degree and PhD. The Prime Minister is asking him to provide opinion regarding: energy trends (including export potential); the likely environmental and human health impact of nuclear vs other types of carbon free energy; and the environmental impact of redeveloping and expanding East Resourcian mining operations. She has also asked the scientific advisor to help soothe societal tensions in the region and, in the long run, find the way for skilled Crossroaders and their families to integrate into East Resourcia.

Task

The science advisor (or advisory mechanism) must provide a report to the Prime Minister in six months (leaving sufficient time for deliberation before the federal election) on prospects for regional development in East Resourcia. In particular, the Prime Minister wants to know:

- energy trends (including export potential) of uranium vs hydroelectric, and the province's potential with regards to each;
- the likely environmental and human health impact of nuclear vs other types of carbon free energy;
- the environmental impact of redeveloping and expanding East Resourcian mining operations.
- The human resource requirements of the province if the mining and energy sectors were to be developed and expanded, and how these needs can best be met
- the sociological profile of the population, its ability to cope with economic and demographic change and how transition can be facilitated

A series of consultations with stakeholder groups is being set up to inform the report process. There is also opportunity for public submissions.

Setting up the Discussion

At least five categories of stakeholder can be identified:

1. Political Perspectives

- a. Federal Democratic Party
 - The current governing party
 - Responsible for the current health and environmental regulations
 - Concerned about upcoming election (threatened by possibility of right wing coalition and loss of Federal seats in East Resourcia)
 - Need to be careful to distinguish policy and politics (due to close election timing)

- b. Federal People's Party
 - Right wing and essentially anti-immigration
 - (Superficially?) concerned about social cohesion for linguistically distinct East Resourcia, despite the possible separatist movement
- c. Federal Green Party
 - Born from an anti-nuclear platform
 - Now essentially anti-mining (or mining expansion)
- d. Provincial Spirit Party of East Resourcia
 - Main platform is to support the linguistically distinct East Resourcians. This group will be worried about integration of a large wave of foreigners in one remote region of the province.
 - Would prefer the 'fast-track' money is spent retraining existing population or repatriating those who've left to pursue jobs elsewhere.
 - Party is at the heart of a long slow-burning separatist movement
 - They could shift the balance for the ruling party in the federal election if they team up with the Federal People's party to campaign for Federal seats in the region.

2. Policy (government) perspectives

- a. Federal Ministry of Labour and Immigration
 - Jointly devised the new fast-track scheme and has an interest in seeing it succeed
 - Has announced the additional program to reconnect fast-tracked migrants with families who were not eligible under the original scheme. It is not known how this program will resonate provincially (Province does not appear to be a partner). Could it lead to tension, given the resistance in the provincial and local media about the new comers?
- b. Provincial Ministry of Labour and Immigration
 - Jointly devised the fast-track scheme and has an interest in seeing it succeed
 - Will be particularly interested in regional development and renewal in this part of East Resourcia
 - May be ambivalent about the additional program to reconnect families that the Federal Ministry has established without collaborating provincially, but with potentially significant societal and political consequences provincially – thus a potential tension between the levels of government
- c. Federal Ministry of Energy
 - Is the ministry responsible for lifting the longstanding moratorium on uranium mining and adding to this the further development of a processing plant for the uranium.
 - Ministry is also open to exploring the development of nuclear energy plants, which would be a new direction for the province and the country, following the moratorium.

- Has been working with the mining sector to develop decisions and planning, but will the Hydro-electric sector have a counter-argument for the ministry to consider?
- d. Federal Regulators (Health Ministry / Environment Ministry)
- There have been new regulations established during the tenure of the current government. Regulators may have an interest in applying them, but not seeing them tested severely on the public stage as they are dealing with the government that brought them in.
- e. Mayor of the town where uranium mine and processing plant to be located
- Is at the frontline of the debate in the media and around town
 - Is concerned about social cohesion of two culturally distinct communities
 - Is concerned about the local social services required to integrate the migrants: schools, community groups, interim housing, language classes
 - Wants local economic development, but must weigh this against social cohesion and the politics of language/culture that have a long history in the province.

3. Industry perspectives

- a. The mining sector
- Has a strong vested interest in lifting the moratorium on uranium mining
 - May or may not be equipped to meet modern environmental and health standards put in place since the sector was last active
 - May or may not be equipped to process the raw uranium ore into 'yellow cake' for export and/or further processing into enriched uranium for fuel.
 - Has a strong interest in the fast-track program to boost human resources
- b. The prospective nuclear energy public-private partnership
- The policy discussion is in its infancy
 - There is no current nuclear-power infrastructure and expertise will need to be sourced for this massive project
 - A number of foreign energy companies have expressed interest in co-development with the government
- c. The hydro-electric energy sector
- Has been the dominant provider of energy for the province and in many parts of the country as a whole.
 - Was recently semi-privatised, so there is a multitude of companies but also sector-wide government relations body
 - Has a strong interest in maintaining its market share and feels threatened at the prospect of nuclear-energy entering the sector.
 - The mining company is a huge prospective client (or existing client, but now with increased energy needs to re-boot and ramp-up the uranium development), however the long term consequences of mining is the ushering in of a serious competitor in the energy sector. The hydro-companies feel ambivalent

d. The tourism sector

- Has grown in recent years during the uranium moratorium
- Has promoted 'eco-tourism' (hiking, mountainbiking, 'glamping') alongside more traditional pursuits of the region (hunting and fishing)
- Has been a key pillar in the provincial government's regional development plan during the moratorium years
- Feels threatened by the spectre of increased mining, particularly contentious uranium mining that will affect the area's tourist brand

4. Mainstream media perspectives

a. The provincial mainstream media

- is openly sceptical about redeveloping the mining industry but has long called for regional development

b. Local media (close to the mine site)

- has been increasing their coverage of radicalisation of newcomers in other countries and stories about the lack of community and social services in the recipient towns to absorb the influx

5. Civil Society perspectives

a. Local population

- As represented by Churches and service clubs, etc. which are largely aligned to the culturally and linguistically distinct sector of the population and have historically served as a base for their cultural activities. Such organisations would normally be deeply involved in supporting newcomers to integrate, but they are ambivalent about this prospective wave of newcomers.
- Majority are from mining families (the towns of this region of East Resourcia were founded and built by mining companies from the 1920s onwards)

b. Local social services providers (Red Cross, SA, YMCA...)

- These groups are often a first port of call for integration of newcomers
- The services they provide rely on both government and private donations
- Their resources at the local level may be stretched to accommodate rapid influx in a small town

c. Crossroader cultural association

- A small group of Crossroader organisers who are among the first to have moved to East Resourcia before the current expected influx.
- Are actively trying to dispel myths and rumours about Crossroader culture and religion and are working to create a positive image of the incoming migrants. They do not wish to be thought of as refugees and the majority are highly skilled and educated, with a level of education exceeding that of the local population on average.

Thematic Considerations

Socio-cultural considerations

- The relationship between social cohesion, social capital and support for welfare policies.
- The link between immigration and social cohesion¹
- Policies designed towards immigrant integration: what has been successful?

Demographic and economic considerations

- Impact of incentive policies to stop/decrease population decline
- Impact of policies developed to drive up the workforce in particular sectors/with particular skills
- Impact of policies targeted at slowing down emigration and attracting emigrants back

Energy considerations

- Energy trends: the likelihood of the pro-nuclear trend to last.
- Comparisons of energy efficiency and cost, nuclear versus hydropower

Environmental and human health considerations

- Greenhouse emissions, comparisons nuclear vs hydropower
- Estimates of environmental and human health cost/impact of nuclear power, in particular in relation to the environmental and human (not only health but also change of life) impact of hydropower.

Debate

Together with your group, use the case to discuss the interconnections of science and policy. Follow the specific instructions of the moderator to organise the debate.

Taking up the task of producing a comprehensive scientific report in a complex situation of high political tension, multiplicity of interests and an emotional public discourse, one has to consider a number of general questions, including:

- Where is the likely greatest area of scientific uncertainty?
- What is the likeliest inconvenient truth i.e. the scientific evidence most unwelcome to the Prime Minister or the general public?
- Where is there the greatest risk of biased evidence?
- What single action from the scientific advisor would build the greatest consensus about the evidence?
- What piece of evidence is likely to be most decisive in the Prime Minister's eventual decision?
- Which is likely to be the most "irrational" argument in the public debate?

¹ Most research analyses the connection between diversity (religious, ethnic) and social cohesion but not immigration.

CASE STUDY – SCIENCE ADVICE WORKSHOP

RHODECAR

Creating employment through waste management

Written by: Brïte Pauchet, Julie Dirwimmer



Automated collection of household waste in a subdivision

RHODECAR:

Creating employment through waste management

Note: the facts and data presented in this case study are fictitious and should not be taken to represent actual people, countries or events.

Context

Rhodecar is a country with a population of 10 million and a per capita GDP of \$42,747, ranking it 30th in the world. It has mild summers and harsh winters, with an average temperature of -15°C from December to March. One third of the population (3 million) lives in the greater metropolitan area of the capital, Recadon. The rest of the population is dispersed in towns and villages spread over a vast area of 800,000 km² (about half the area of Québec) containing large forests and fertile plains. The main agricultural activities are intensive grain and soya production, as well as poultry and pork farming.

Historically, Rhodecar's economy has been based on the exploitation of natural resources (uranium, oil, cobalt, spring water, timber). Indeed, mining companies, whose profitability is subject to the vagaries of the market, remain a major employer in several administrative regions. Depending on the year, unemployment rates range from 5% and 12%, with a wide variability between regions. A few years ago, in the hope of creating jobs for their residents and diversifying their sources of income, several municipalities, including Annevere and Bourg de Carau, both in the Chirisain region, began investing in insect farming and outdoor tourism. In the capital and its surrounding area, the techno-industrial sector dominates the market, with head offices in the city centre and many businesses in the metropolitan area.

Rhodecar imports 50% of its food and 40% of its energy from neighbouring countries. Its inhabitants generally enjoy a good quality of life. School is free and compulsory until 16 years of age. The majority of students continue their education in public post-secondary institutions. The country advocates freedom of expression and freedom of enterprise.

Rhodecarians live under a single-chamber parliamentary democracy. Historically, power has alternated between two parties: the protectionist / nationalist Rhodecarian Party, and Change For Rhodecar, which seeks to boost employment through international trade. Two other parties were founded some fifteen years ago: Green Rhodecar, an environmental party, and Rhodecar For All, which focuses on social measures and supporting the birth rate.

The last elections led to a majority government whose main objective is fighting unemployment and the

devitalization of outlying regions. Indeed, many of the elected Change For Rhodocar members, including the Prime Minister, are from regions that are suffering the full force of the global economic recession. The Prime Minister's home village of Outeciplou, in the Chirisain region, is currently experiencing a major unemployment crisis following the closure of a foreign manufacturing company. This closure led, directly or indirectly, to a loss of employment for almost half of the village population. Other regions are affected by similar conditions, but to a lesser degree.

Party	% Votes	Number of Seats
Change For Rhodocar (CFR)	39%	65 (52%)
Rhodecarian Party (RP)	26%	34 (27%)
Green Rhodocar (GR)	21%	16 (13%)
Rhodocar For All (RFA)	14%	10 (8%)

Rhodocar is internationally renowned for its nature and its landscapes: rolling green hills, forests rich in biodiversity, pristine lakes and streams. In the south, one quarter of the country's land is governed autonomously by the Council of Indigenous Peoples, a governance body put in place by Rhodocar's 21 indigenous peoples (representing close to 10% of the population), in consultation with the country's government.

Rhodocar produces nearly 60% of its energy through six state-of-the-art nuclear power plants located 500 km outside the capital. The rest of its energy comes from the neighbouring country, Aurederia, which has the differences in elevation necessary for producing hydroelectric power. Relations between the two countries cooled seven years ago following a diplomatic incident. The situation has since improved, but relations remain strained, especially when it comes time to renegotiate trade agreements between the two countries.

Given this context, the government is actively seeking new energy sources in order to eliminate its energy dependence.



Illustration: Martin PM

PART 1 - Problem

Aware of the importance of preserving their environment, several regions are asking for a waste management centre like that in Recadon, which has been composting the capital's food waste for 25 years. Many municipalities want to rehabilitate their garbage dumps, which undermine the idyllic image of their region, in order to meet the standards of the International Outdoor Tourism Group.

The government is open to exploring new waste processing options, including in outlying regions, where the goal would be to collect waste in a group of neighbouring municipalities and process it at a single location. To do this, it plans to make a major investment of 500 million Rhodecarian dollars (RHO \$) over 4 years.

The region chosen for the pilot project is Chirisain, which is home to 1.5 million inhabitants in an area of 15,000 km² of lakes and forests. The government wants to fulfill a key promise of its election campaign: to revitalize an outlying region through the creation of sustainable, well-paying jobs. The region currently generates 720,000 tons of waste per year. The region's inhabitants do not currently sort their waste for recycling. In each village, waste is buried in landfills, an operation which costs the region the tidy sum of \$43 million RHO per year.

Following a public call for tenders, three projects were submitted to the government: one using biomethanation, another using composting and a third using gasification (see data sheets). The potential contractors opted for three different technologies, each of which appears to have its advantages and drawbacks. It is now time to choose who will carry out the project. Work should begin in the year following the signing of the service contract. With this project, government economists expect the creation of close to a thousand jobs during the four years it will take to build the plant, as well as 300 permanent jobs once it is in operation.

The Minister of the Economy, who holds a seat in one of the counties of the capital, Recadon, is in charge of the file. It is to be expected that many of the decisions concerning the development of the project will cause tensions within the Cabinet, especially between the Ministers of Transport, Tourism, the Environment and the Economy.

The Prime Minister wants to make this project possible and is seeking to arbitrate these tensions in the best possible manner. He asks his chief scientists to put together a committee of experts to inform him about the technical aspects of the project, as presented in the proposals of the three contractors, in an independent manner.

Response to the call for tenders *Waste: energy of the future for Rhodécari*. Summary prepared by the Rhodécari Ministry of the Economy.

Compostair Inc. Project: Composting with gas capture

Project leader:

Compostair Inc. is a Rhodécari waste treatment and exploitation company. Founded 25 years ago with government support, it designed the composting-based waste management system of the city of Recadon and oversees its operation.

Project summary:

Compostair Inc. proposes to set up a large-scale composting plant for the Chirisain region, in the village of Bourg de Carau, in an isolated area currently used as a landfill site. This plant will be able to process all of the region's household food waste using windrow composting technology, and will recover the gases emitted from previously buried waste to generate biogas.

The Chirisain region will have to improve its road infrastructure for the transport of food waste to the village of Bourg de Carau. This infrastructure can also be used to transport compost to agricultural areas in the floodplains, where this high value-added organic material can be used by large grain production cooperatives or packaged for export. Once compressed, the gas recovered from the old landfill area will be used to fuel a new fleet of collection trucks.

The arrival of Compostair Inc. in the region will create sustainable, low-skilled jobs that can be filled by people from natural resource industries who are currently out of work. The transition of municipalities to sustainable development will be accelerated with the establishment of a selective household waste collection system for citizens and businesses.

Cost of setting up the plant:

- Design and installation of the composting and landfill gas recovery plant: \$82 million RHO
- Investment in natural gas distribution infrastructure: \$23 million RHO
- Investment in a fleet of compressed gas vehicles: \$10.4 million RHO
- Increased maintenance costs associated with more frequent repaving: \$15 million RHO
- Adaptation of household waste collection practices: \$15.2 million RHO
- Recurring costs: energy needs covered by the recovered gas + operating and maintenance costs of \$45 RHO/t OM (or \$11 million RHO/year).

Expected economic impact:

- 430 jobs for 5 years for the implementation of the project (100% Rhodécari, including 60% from the capital, Recadon), and 70 jobs for running the plant on the medium term (80% local employees).
- The sale of compost will generate \$12 - \$15 /t OM depending on compost quality, for an expected annual revenue of \$2.9 to \$3.6 million RHO per year.

Response to the call for tenders *Waste: energy of the future for Rhodécar*. Summary prepared by the Rhodécar Ministry of the Economy.

Methagreen Inc. Project: Biomethanation

Project leader:

Methagreen Inc., an Aurederian company, is a key player in that country's agriculture sector. In collaboration with the Aurederian government, it set up a joint treatment system in Aurederia for agricultural waste and sewage sludge, providing large agri-food companies with access to energy resources at very competitive prices.

Project summary:

Methagreen Inc. proposes to set up a waste treatment plant using wet biomethanation, like the process used to treat agricultural waste on large farms. Adapted to a regional scale and using co-digestion techniques, the plant will be able to process all the household food waste and sewage sludge produced in the Chirisain region. It will be set up right next to the regional water treatment plant, on the outskirts of Outeciplou.

The biomethanation plant will produce heat and electricity. The electricity can be used to run the plant, the water treatment plant and a fleet of transport trucks, while the heat can be used by the municipality or the Mangemoi insect farming cooperative. If the yield is sufficiently high, an agreement could be signed with Uramine uranium mining company, which would invest in the project in exchange for access to the surplus electricity produced, at a competitive price.

Access to this resource will provide municipalities in the Chirisain region with a highly cost-efficient option for investing in a fleet of electric vehicles, allowing the transport of waste at a low cost. Municipalities will accelerate their transition to sustainable development through the establishment of a three-tiered selective household waste collection system for citizens and businesses.

Cost of setting up the plant:

- Design and installation of the biomethanation plant and adaptation of the water treatment plant: \$490 million RHO
- Investment in electrical connection infrastructure for the biomethanation plant: \$1.3 million RHO
- Investment in a fleet of electric vehicles: \$31 million RHO
- Adaptation of household waste collection practices: \$8.4 million RHO
- Recurring costs: operating and maintenance costs of \$45 /t OM (or \$11 million RHO/year), energy needs of 100 kWh/t OM, in addition to the energy needs of the treatment plant and the fleet of electric vehicles.

Expected economic impact:

- 380 jobs for 3 years for the implementation of the project (40% Aurederian immigrants), and one hundred jobs for running the plant on the medium term (70% local employees).
- Electricity production of 350 kWh/t OM, of which 50 kWh/t OM could be made available to a company, generating revenues of up to \$1.6 million RHO per year.

Response to the call for tenders *Waste: energy of the future for Rhodécar*. Summary prepared by the Rhodécar Ministry of the Economy.

Tokoflam Inc. Project: Gasification

Project leader:

Tokoflam Inc. is an Iridian consultation and operationalization company for industrial and domestic waste treatment that stands out in the global market with bold service offerings. Tokoflam Inc. is not yet present in Rhodécar or Aurederia.

Project summary:

Tokoflam Inc. proposes the establishment of a waste treatment plant using plasma torch gasification. This innovative process is still rarely used outside of Iridia. It requires complex technology to which Tokoflam Inc. holds the patents. The plant and process will be able to treat all household waste produced in the Chirisain region, as well as some of its household plastic waste.

To make the best use of the electrical energy produced by the plant, Tokoflam Inc. proposes to simultaneously design and build an auxiliary tertiary wood processing plant, which will be fully powered by the waste treatment process. Tokoflam Inc. has already approached a large forestry company which, with the help of investment at the national level, could develop its transformation activities to increase exports of finished products with a higher added value. Tokoflam Inc. also plans to transform part of its syngas into ethanol and methanol, two products with high added value. Furthermore, the company points out that this technique does not require prior sorting of household waste.

As the project will require an extremely specialized workforce, labour needs will be partly covered by foreign workers. A training program will be developed in partnership with the country's polytechnics network to build a local workforce in the medium term. The government will need to strengthen its infrastructure for the safe transport of waste within 48 hours of its collection, as well as for the regional transport of wood for the processing plant.

Cost of setting up the plant:

- Design and installation of the gasification plant: \$1.296 billion RHO
- Design and installation of the wood processing plant: \$18.4 million RHO
- Adaptation of municipal safety standards (expansion of industrial zone, possible expropriation of private land): \$16 million RHO
- Partnership with polytechnics network: \$4.2 million RHO
- Recurring costs: energy needs of 400 to 800 kWh/t of waste + 85 \$/t OM for plant maintenance and operations (or \$31 M/year)

Expected economic impact:

- 420 jobs for 5 years for the implementation of the project (60% specialized Iridian employees), and 160 jobs for running the plant on the medium term (80% local employees). In addition, the wood processing plant will create about one hundred local jobs.
- Energy production will be between 900-1800 kWh/t of waste, at a value of \$25-\$50 /t of waste, for a revenue of \$9 to \$18 million RHO per year.

Proposal costs and benefits summary tables

	Composting (\$million RHO)	Methanation (\$million RHO)	Gasification (\$million RHO)
Design of waste transformation plant	82	490	1,296
Design of auxiliary plant	-	-	18.4
Cost of adapting transport infrastructures	15	31	-
Other investments	10.4	-	16* 4.2**
Investment in infrastructure for energy transport	23	1.30	-
Cost of waste collection adaptation	15.2	8.40	0
Total investment	145.6	530.7	1,334.6

* (safety standards)

** (polytechnic program)

	Composting	Methanation	Gasification
Recurring costs	\$45 / t OM \$11 million / year	\$45 / t OM \$11 million / year	\$85 / t OM \$31 million / year
Energy requirements	0	> 100 kWh/t OM	400-800 kWh/t OM
Profit (\$million RHO)	2.9 – 3.6 /year	1.60 /year	9 - 18 /year

The current cost of waste treatment is \$16.2 million RHO per year.

PART 2 - Problem

As the project developer is being selected, commercial tensions heat up with neighbouring Aurederia.

Several mayors in the Chirisain region are disappointed with the choice of location for the plant. They had been hoping to benefit from significant land revenues and jobs. Within the municipality itself and its neighbouring villages, the population is divided: while there is some public support for the project, many citizens oppose it. Also, the village cooperative, which wanted to set up local composting of organic waste, had its project refused by the municipality on the pretext that the regional system would be up and running within 5 years.

Many citizens are concerned about the impact of the construction and operation of the plant on their quality of life (noise, odor, pollution, increase in road transport, etc.). Some are mobilizing to make their voices heard through the association Citizens for Health. In addition, there are rumours that the promised jobs will require specialized skills that few residents have.

Indigenous municipalities and villages near the project site, led by Annevere, are raising the red flag. Under the previous government, these communities had agreed on a green tourism development plan, for which the government agreed to invest close to \$600 million Rhodecarian over five years. They feel that the waste management plant project, and the infrastructure it requires, could cost the region its newly-obtained International Outdoor Tourism Group certification.

However, the government wants to quickly start building the integrated waste treatment system in order to achieve energy independence within five years.

The Minister of the Economy decides to hold public consultations to address the protests that are preventing the project from moving forward.

PART 3 - Problem

As elections are held on a fixed date, citizens are called to the polls. The election results are as follows:

Party	% Votes	Number of Seats
Change For Rhodecar (CFR)	33%	52 (42%)
Rhodecarian Party (RP)	29%	47 (38%)
Green Rhodecar (GR)	23%	17 (14%)
Rhodecar For All (RFA)	15%	10 (7%)

As they have lost their majority, Change For Rhodecar decides to form an alliance with the Green Rhodecar party to form the new government. The incumbent Prime Minister and leader of the Change For Rhodecar party holds onto his position as Prime Minister. He keeps his very efficient Minister of the Economy by his side. Meanwhile Green Rhodecar has secured what it considers to be two key ministries: the Ministry of Health for the party leader (elected in the capital, Recadon) and the Ministry of the Environment for the deputy leader (elected in Annevere).

The Green Rhodecar party made strong electoral gains on the strength of one of its key promises: a review of the government's environmental policies and, in particular, a review of its waste treatment plant project.

The Prime Minister and his team are forced to review the waste treatment plant project in light of the new composition of the Cabinet.

(Document not provided to participants)

PART 1 – Procedure:

- Introductions
- Distribution of roles and information sheets
- Simulations:
 1. The Chief Scientist is tasked by the Prime Minister to evaluate the technological aspects of each project, a mandate that is quite limited as it does not include social and economic aspects in the evaluation. She chairs the first meeting of the committee, which is made up of three experts. Each expert will have a few minutes to comment on the three technologies from the point of view of his/her area of expertise, and then the Chief Scientist will lead a discussion on the recommendations that should be made to the Deputy Minister.
 - Chief Scientist
 - Infrastructure researcher
 - Environmental researcher
 - Process chemistry researcher
 2. This project sparks public debate, especially the choice of location for the plant. How was this location chosen, and by whom exactly? Nobody seems to have a clear answer to these questions. A researcher gives an interview on Chirisain regional television, to take a position on the choice of location.
 - Public health researcher from the greater Chirisain area
 3. The Chief of Staff and Deputy Minister meet with the Minister of the Economy to take stock of the situation.
 - Chief of Staff
 - Deputy Minister

(Document not provided to participants)

PART 2 – Procedure:

- Distribution of roles and information sheets
- Simulations:
 1. The Ministry of the Economy launched a series of regional consultations, focusing on the regions where there was greatest opposition to the project. In the absence of the Economy Minister, who is busy preparing for upcoming economic negotiations with Aurederia, the Chief of Staff attends some of these consultations, including the one in the Chirisain region. The participants take turns presenting their points of view, and also challenging each other:
 - *Citizens for Health* association
 - Mayor of the chosen municipality
 - Manager of the largest fishing outfitter in the region
 - Representative of the developer chose following the call for tenders
 - Economics researcher
 2. That same evening, the Chief of Staff briefs the Minister of the Economy on the outcome of the consultation, knowing that she will have to answer questions the next day at a media scrum or during question period in parliament.
 - Chief of Staff
 - Minister of the Economy
 3. Media scrum with the Minister of the Economy: the Minister is asked to respond succinctly to brief questions of all kinds.
 - Minister of the Economy

(Document not provided to participants)

PART 3 – Procedure:

1. Distribution of roles

1. Prime Minister (CFR)
2. Minister of Transport (CFR)
3. Minister of Municipalities (GR)
4. Minister of the Economy (CFR)
5. Minister of Public Safety (CFR)
6. Minister of the Environment (GR)
7. Minister of Health (GR)

2. Simulation

To prepare his Cabinet, the Prime Minister summons some of his ministers in order to find ways to come to an agreement.

INGSA WORKSHOP MATERIALS

SWAMPERIA:

Future technology in the fight against malaria

Writing team: Kristiann Allen, Peter Gluckman and James Wilsdon



ANOPHELES ALBIMANUS MOSQUITO FEEDING ON A HUMAN ARM

SWAMPERIA:

Future technology in the fight against malaria

Note: materials in this case are fictional and should not be taken to represent real-life people, places or events.

Swamperia is a country of diverse and beautiful landscapes. It is a lesser known tourist destination for travellers seeking more ‘off the beaten track’ experiences – with a number of high-end eco-lodges. However the country’s reputation as a ‘malaria zone’ has been an impediment to its further development of its tourist potential. It is rich in freshwater resources including lakes, rivers and wetlands. Swamperia’s largest crop (domestic and export) is paddy rice. Economically, Swamperia is among the least developed countries in the region, relying on its limited rice exports, forestry, and its limited tourist sector for economic development. However, there is sadly a very high rate of cerebral malaria in Swamperia, which is due to infection with *plasmodium falciparum* carried by the anopheles mosquitoes that are endemic to much of the country.

Background and context

In 2019 malaria infection led to 200,000 deaths mainly of children under the age of 5. In total, there were 500,000 cases in the population of 12,000,000. In the past decade, both the ministry of health and international organisations have put considerable effort into health promotion practices such as education and action on eliminating standing/stagnant water near villages and promotion of the use of effective insecticide treated bed nets. Surveys have shown that bed net use has not been widely adopted by the population.

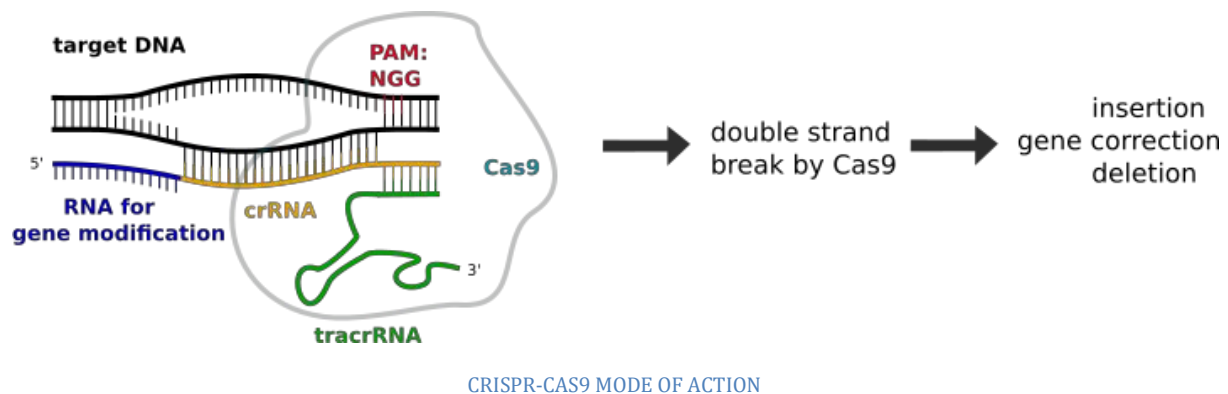
In 2016 a trial of a vaccine against malaria produced by a European drug company had been conducted in Swamperia. This trial involved 4 immunisations over three years and was thus deemed to pose a high burden on the already over-stretched public health system. Furthermore, the trial showed only partial protection. It appeared to reduce the death rate by about 15% and was 30% effective in children. The vaccine use was associated with about a 10% rate of side-effects, which included persistent joint pain in adults.

The local healers claimed that the side-effects are evidence that western medicine is harmful for Swamperians. They advocated for the continued use of an infusion of local herbs, which have long been known to provide analgesic effects, but which have no known properties to combat the *plasmodium falciparum* parasite. The healers remain vocal about the issue.

The dilemma

It is now 2020 and a global consortium of scientists funded by the philanthropically supported Global Anti-Malaria Foundation (GAMF) has announced that ‘anti-malarial’ anopheline mosquitoes that they created in 2015 are now ready for uncaged field trials in real-world environments. These mosquitoes

were developed using a gene-editing technique called CRISPR-Cas9 and have a highly penetrant gene-drive quality, which means that they can pass the edited gene on to offspring so that the sought-after characteristic will continue in subsequent generations of the mosquitoes. The characteristic in question is the inability of the gene-edited mosquitoes to incubate the *falciparum* parasite that causes cerebral malaria. Scientists are satisfied that the gene-edited mosquitoes pose no danger to humans and have not seen any negative consequences to the controlled laboratory ecosystems in which the gene-edited insects were trialled.



A wider release of the mosquitoes would now be needed to determine their effect on malaria rates and to monitor ecosystem impacts in endemic regions. The Prime Minister has recently been approached by GAMF to consider whether the first field release could be in an area of Swamperia with high infant mortality rates from the disease. A partnership between GAMF and a European university-based biotech company has been established to conduct the longitudinal trial of the modified mosquito (currently planned for 5 years), which is widely seen as the most promising tool in the fight against malaria. They have invited the only medical school in Swamperia to be a partner in the trial, including the joint licensing of eventual IP and commercial products.

GAMF proposes that the trial would need to include a multi-disciplinary team of geneticists, virologists, ecologists, and community health practitioners. The funding is available, the commitment is obvious, and a robust methodology and infrastructure is in place. If negotiations for a Swamperia release fail, GAMF is considering pursuing approval for release in one of two neighbouring countries.

At the same time, malaria vaccine research has continued at some of the most reputable labs in the world (CDC, London School of Tropical Medicine). The aim has been to refine the initial candidate vaccines to improve effectiveness and affordability. Progress has been slow and there is no guarantee that the vaccine will not pose the same pressures on the medical system as previous attempts, but many governments – including Swamperia, are watching closely.

Also watching closely is a well-funded international environmental organisation that is known for its anti-Genetic Engineering stance (in the environmental sector). Traditionally, this group does not protest genetic modification for vaccines and medicines but the, but the gene-edited mosquito is an important issue for them because it crosses the boundary from health to environment and the long-term ecosystem consequences are unknown. This organisation is offering to help the Swamperian

Government fund access to a malarial vaccine if they agree to deny approval of the gene –edited mosquito release. It is clear, however, that their funding would be time-limited.

The role of scientific advice

In light of the time pressure to approve the mosquito trial, Swamperian government officials are seeking advice from their science advisor on all the possible scenarios. What considerations would have to form part of a report from the advisor to the Government?

PHOTO CREDITS

COVER: Anopheles albimanus mosquito feeding on a human arm.. Credit: James Gathany, via Centers for Disease Control and Prevention Public Health Image Library (PHIL), ID #7861. Public domain, <https://commons.wikimedia.org/w/index.php?curid=3045248>.

PAGE 3: CRISPR-Cas9 mode of action. Credit: Victoria Anselm, CC BY-SA, https://commons.wikimedia.org/wiki/File:CRISPR-Cas9_mode_of_action.png.



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INGSA CASE STUDIES

TANGERIA: GENE-EDITING AND CLIMATE RESPONSE: SCIENCE, VALUES AND POLITICS



TANGERIA

GENE-EDITING AND CLIMATE RESPONSE: SCIENCE, VALUES AND POLITICS

Context

Tangeria is a presidential representative democratic republic that has a high literacy rate and a low corruption index. The President of Tangeria is the head of the state and the head of the government. The parliament is formed by proportional representation with a number of parties both in the government and opposition. A pro-environment party is a significant voice in the parliament but is not in government.

The government is formed from a coalition (“National Alliance”) between a business–friendly party with an urban voter base and a largely rural party. It was elected on a platform of promoting economic growth for the regions. It is three years away from the next election, which occurs every 5 years. Opinion polls suggest the public is worried about the government’s performance in sustaining economic growth. Climate change is high in the public consciousness: its importance is not debated as there is a broad consensus that Tangeria must address its emissions profile which largely comes from pastoral agriculture, transport and energy production (60% of its energy is produced from coal – much of it by trans-border importation from a neighbouring and more authoritarian country, Energeria, which has surplus energy).

But notwithstanding the broad based acceptance of climate change as a matter to be addressed, the opposition regards the actions taken by the government as timid consensus. After the Fukushima event, Tangeria shut down its only nuclear power station and doubled imports of coal derived electricity from Energeria. At the same time a prominent local celebrity has launched a high profile campaign about the state of the environment – demanding more action on climate change and greater protection of Tangeria’s national parks.

Tangeria has a significant, export-oriented agricultural component to its export economy (based on the production of beef and corn/maize which is mainly used as a cattle feed in the dry months and a significant horticultural economy – mainly of fruit and vegetables – which relies heavily on irrigation from water sourced from a large aquifer). Farming is still largely a family affair but large farming corporations are becoming more established, especially as the population generally ages and urbanises. Politically there are concerns about the declining state of the rural economy, the emptying out of provincial towns and the social consequences of rapidly increasing urbanisation. This is impacting on the governing coalition and causing tensions within it.

Modelling suggests that because of climate change, Tangeria will face increasingly wet conditions which will affect pasture growth. Indeed in four of the last five years there have been unusually severe rains affecting agricultural production due to a decline in suitable pasture, a greater dependence on maize production to feed the cattle and depressing horticultural growth rates.

About two decades ago, the country previously rejected the use of genetically modified organisms in agriculture and food production, although foods containing GM grain and soy are now imported

from Energeria, a neighbouring country that grows GM crops. GMO-containing foods are sold in most supermarkets although not explicitly labelled as such. They may also be found in animal feed. Indeed, Tangeria is a member of a free trade block in which some countries grow GM crops and some do not. The opposition to the ruling “National Alliance” is demanding the labelling of foods that contain GM products beyond trace levels, although there is no consensus as to what that means.

The debate 20 years ago was intense, with opponents of GMOs promoting scientific uncertainty and precaution as the reason to ban them. Today, however, there is growing pressure on the government from the farming sector and rural business leaders to protect the sector by addressing the impending shift to more arid conditions with a technology-based climate change mitigation strategy.

The warmer wetter conditions have also brought a greater number of pest species of weed into the Tangeria ecosystem. One weed, the Emperor Grass, has rapidly spread. It has not only invaded cropped landscapes to the point where it is interfering with machine harvesting, but it is also host to the Emperor maize weevil, which in the past was not a problem in Tangeria. Now, however, it is affecting agriculture because the weevil preferentially eats the growth buds of maize and several horticultural crops. Glyphosate appears to be the only herbicide that eliminates the Emperor Grass. Farmers want to use far more glyphosate but they have the challenge that glyphosate also will hurt their crops. They are keen to start using glyphosate-resistant maize, originally developed as a GM-modified strain and now available as a gene-edited strain. The latter was developed at Tangeria National University (TNU).

TNU scientists claim that new breeding techniques based on gene editing show promise for developing drought-resistant crops and plants. In general, such new molecular techniques do not involve the insertion of foreign genetic material into the plant. Rather, they work through the targeted manipulation of one DNA nucleotide in the gene that regulates certain pathways, expressed as drought resistant characteristics in the plant. TNU scientists report that they have successfully crossed the construct used for drought resistance with that that confers glyphosate resistance to create the “ideal” maize crop for Tangeria: indeed they are calling it ‘super-maize’

The technology’s proponents claim that this gene-edited maize is no different to traditionally bred varieties. They also argue that gene editing is safer and more targeted than many of the current, less targeted crop-development techniques, through radiation or chemical toxins. They furthermore state that there is no scientific evidence to think that these methods should be considered risky.

Others, including some scientists, have publicly invoked one version of the precautionary principle, suggesting that these techniques should not be introduced unless proven absolutely safe. They raise the potential risk of microRNAs in the foodstuffs, originating with this technique. They also claim that the new strain would lead to the excessive use of glyphosate. Indeed, as they sense some growing sympathy for the use of new technologies/ they have started to claim that the risks with glyphosate make the introduction of this super-maize downright dangerous. Although Tangeria is not part of the EU, the environmentalists are pointing to the WHO’s and EUs rulings on glyphosate (see below) as reasons for banning extensive use of glyphosate in crop framing.

Organic (and many conventional) farmers suggest the super-maize will hurt their markets. There is yet to be any structured political or public debate over the acceptability of these new techniques. At the same time, the farming community is pushing hard for progress: they have even started to suggest that they would increase the area of land used in cropping so as to make synthetic meat rather than expand the number of cattle – this would help reduce greenhouse gas emissions, water and energy use (they claim). A farmers business cooperative (Tangeria Advanced Agriculture Cooperative Incorporated, TAACI), chaired by a previous minister of business and innovation and former leader of the rural party and coalition partner, has licensed from a Californian company the rights to make synthetic hamburger meat from cropped plants. Their goal is to produce meat for the mass market at a price that competes with ground beef. They have funded TNU to undertake some necessary scale-up research to make this a realistic possibility

Officials in Tangeria's Treasury estimate the net value of moving to weather resistant crops as a climate change adaptation measure is in the order of 2% of GDP. They see a similar massive upside from suppressing the Emperor weed by extensive use of glyphosate. There is also an argument put forward that these crops would allow for farming systems with less dependence on livestock and thus reduce agricultural greenhouse gases.

Dilemma

The National Agricultural Research Institute of Tangeria (NARIT) wishes to test the new varieties of super-maize and pasture grass produced by gene-editing. The institute has been promised strong financial support from TAACI who are prepared to meet 75% of the development costs. There is also interest from UN organisations that are promoting better responses to the International Sustainable Development Goals. NARIT is well positioned to become a world leading research and innovation hub in agricultural gene editing technology and indeed this is part of the institution's stated strategic plan.

Leading scientists from both TNU and NARIT maintain that gene-editing techniques do not produce GMOs in the conventional sense and therefore are not subject to the country's regulations that currently limit the release of GMOs. The proponents point out that there has been expert opinion in several other countries regarding this point with the consensus that these methods are fundamentally no different to standard forms of plant breeding. But those who are opposed point to other countries that do consider that gene-editing techniques should be regulated in the same way as GM.

The Science Advisory Council to TAACI has produced a report on the safety and advantages of glyphosate, which points out the deficiencies in the EU-WHO analysis. This report is rejected by a group called Doctors for the Sustainable Environment who argue that the evidence shows that glyphosate causes cancer.

A regulatory change would be needed before the field trials would be possible. The government is under growing pressure from the farmers' lobby, TAACI and from the minority party in the coalition. Editorials are split with environmental arguments being put both to allow the super-maize and extensive use of glyphosate and others to continue to ban it.

The President of Tanageria and the Cabinet feel the need to clarify their existing policy in light of more precise techniques and to seek advice from their science advisory system about their perspectives on NARITs proposal to field-release the super-maize.

Notes for the mentor

What are the issues/questions that a science advisor or advisory system need to consider when preparing a response?









Points to consider:

What are the scientific issues (as opposed to political ones)?

What is known, what is not known?

Precaution and risk

Communication

1. Communication of complex science to politicians
2. Language/ communication/media – how can to get to the various groups
3. It's going to be fraught – must therefore be careful to be an honest broker
 -  What we know
 -  What we do not know
 -  Risks of moving
 -  Risks of not moving
 -  Alternate approaches, credible
4. Who are all the stake-holders?
 - Broader implications- beyond the science or its communication
5. No social consensus
 -  What are the options?
 -  Dealing with the extremists/lobbyist on both sides of the debate
 -  How can science support debate?
6. Is the economics safe? Is that a question for science advisors?
7. Is the export market safe? Is that a question for science advisors?
8. Alternate solutions for the agricultural sector?
9. Tanageria's global reputation? Does it matter?

Additional material: Review on glyphosate

Summary

Glyphosate (N-(phosphonomethyl) glycine) is a leading herbicide, most notably sold as the compound Roundup, which is used in conjunction with crops genetically engineered to be resistant to its effects. This combination has been introduced to reduce pesticide use and increase yields. Glyphosate is used in hundreds of products, making it difficult to fully test in combination with all the other chemicals with which it might be used. In light of this, its exact toxicity to humans, bees and the environment in general has been difficult to determine. Recently, the license for glyphosate has come up for renewal in the European Union, opening up the debate about a blanket ban once again. This debate has been recently complicated by the WHO's reclassification of glyphosate as a probable carcinogen, a conclusion that was subsequently challenged by the renewal process, during which the report on acceptable risk issued by EFSA concluded.

Introduction

In 1974, the multinational biotechnology corporation Monsanto launched a new broad-spectrum herbicide based on the active substance glyphosate. Marketed under the trade name Roundup, this herbicide was part of the corporation's large scale involvement in the "green revolution", a global project supported by the World Bank that aimed to increase food production in developing countries through the industrialization of agriculture and extensive use of fertilizers and pesticides. At its introduction Roundup could help clear land for cultivation, but it could not be used on arable crops because crop species as well as weeds succumbed.

In the early 1980s Monsanto scientists began working on genetically modified plants engineered for resistance to Roundup, thus allowing use of the compound to remove invasive weed species without damaging the crops. In 1994, the corporation released the first transgenic glyphosate-resistant crops—soybeans and canola, followed rapidly by cotton, maize and sugar beets. The uptake of these transgenic crops was spectacularly fast and wide, first in North and South America then globally. Monsanto claimed this combination of herbicide and GM seed modified to resist the herbicide enabled food producers to reduce the use of other weed-control tools (chemical or mechanical). Furthermore, glyphosate was claimed to be relatively harmless because it bound tightly to soil constituents with little movement through either soil or groundwater, and had a short environmental half-life with no atmospheric contamination because it is not volatile.

Initially, the WHO classified glyphosate as "probably not carcinogenic to humans". Multiple studies found it was not retained in animal tissue, while reports of potential toxicity in humans were generally blamed on surfactants (chemical additives to the Roundup compound), not on the glyphosate molecule itself, which was deemed non-carcinogenic and not developmentally toxic. However, many of the studies reviewed at that time were carried out by Monsanto, and the structure of risk evaluation studies could leave questions about longer-term exposure unanswered.

In 2012, the French scientist with a history of anti-GM claims published a highly controversial paper. To immense and controversial publicity, the paper suggested that Roundup caused tumours in rats when studied over a longer period. This paper was withdrawn by the publisher a year later after

vigorous criticism of its statistical and scientific validity by the scientific community. It was eventually republished without any further peer review in a different journal along with the raw data.

As time went on, it was noted that resistance to glyphosate was beginning to increase in both GM crops and in related weeds through exchange of genetic material, causing farmers to apply other herbicides along with glyphosate-derived products and thus increasing rather than lowering the total volume of herbicide use.¹

Although there has been widespread uptake of GM crops by farmers in the USA and South America, this increase in use has been countered by widespread public resistance in Europe and other regions. In 2015, the EU voted to allow countries to block GM. To date, 19 of the 28 member states have enacted bans.²

At the same time, the active ingredient in Roundup, glyphosate, was coming to the end of its approved licensing period in Europe, having been authorised in 2002. While Roundup accounts for a significant share of the agro-industrial market, including use by home gardeners, glyphosate is also used in a number of other products - more than 750 in the US alone (IARC 2012). It is therefore impossible to test each and every compound, particularly as new products continue to enter the market.

In Europe glyphosate must first be approved at EU level before member states can authorise its use in products for their own markets, and expiry of the approval would require all member states to withdraw authorisation for the sale of products containing it.³ Periodic renewal of this approval is required, and in this instance began in 2012. Although any person can submit information during preparation of the draft assessment report which is prepared by the Rapporteur Member State (in this case, Germany), EFSA is expected to make an active assessment only of the technical evidence it receives.

In March 2015, the International Agency for Research on Cancer (IARC), the cancer-research arm of the WHO,⁴ released a report that assessed the carcinogenicity of five major herbicides, including glyphosate. The commission used evidence from human, animal, and mechanistic studies, i.e. those seeking to explain causative processes. The IARC concluded that there was “limited evidence” from human epidemiological studies to suggest a positive association between exposure to glyphosate and increased risk of non-Hodgkin lymphoma (NHL), as well as increased risk of childhood cancers associated with application of the herbicide by their parents, but other factors could not be

¹ A report by respected consultants PG Economics concludes that pesticide use has in fact decreased by 8.2% due to adoption of GM. However, this company has also been flagged by Lobbywatch.org for having undeclared interests, and its research is often funded by industry lobby groups which include Bayer, Dow, DuPont, Monsanto and Syngenta (see <http://www.lobbywatch.org/profile1.asp?PrId=308>).

² However, many EU countries which ban cultivation do allow import of GM products.

³ See European Commission—Fact Sheet. FAQs Glyphosate. Brussels, 29 June 2016. http://europa.eu/rapid/press-release_MEMO-16-2012_en.htm

⁴ From <http://www.iarc.fr/en/about>: ‘The main objective of the IARC is to promote international collaboration in cancer research...[and] identify the causes of cancer so that preventive measures may be adopted ... The IARC Monographs Programme is a core element of the Agency's portfolio of activities, with international expert working groups evaluating the evidence of the carcinogenicity of specific exposures.’

confidently ruled out. Indeed, a large cohort Agricultural Health Study that follows thousands of agricultural workers found no significant increase of NHL. Animal studies (in mice) showed an increase in the incidence of a rare kidney cancer, and of connective tissue as well as skin cancer. “Mechanistic evidence” referred to the increase of blood markers of chromosomal damage in people after spraying of glyphosate, and evidence of glyphosate, glyphosate-formulations and oxidative stress induced by AMPA, a glyphosate metabolite in rodent and in vitro studies. While accepting that other factors could not be completely ruled out in the association with NHL, the report did conclude that there was sufficient evidence of carcinogenicity from experimental animals and from human in vitro mechanistic data to warrant reclassifying glyphosate from possibly to “probably carcinogenic to humans (category 2A⁵)”.

The IARC report provoked strong response. The agricultural industry and the farming sector were highly critical, with Monsanto accusing the IARC of bias. But a number of other stakeholders—environmental groups, opponents of GM crops, anti-globalization advocates—used the IARC report in new campaigns to mobilize public opinion, particularly in the European Union where there has been longstanding hostility towards GMO. In the face of rising media attention, with retail outlets removing Roundup and similar products entirely (Levitt 2015), the European Commission pushed for faster completion of the regular regulatory review of glyphosate that it had begun in 2012.

In November 2015, the relevant regulator, the European Food Safety Authority (EFSA), released a report that - in contrast to the IARC report - concluded that glyphosate was “unlikely to be carcinogenic”. However, EFSA used a risk based approach, taking into account likely exposure, rather than general potential for harm (i.e. a hazard based approach). Thus it set for the first time safety thresholds for exposure, at 0.5mg per kg of body weight for consumers and 0.1 mg/kg for agricultural operators. The US Environmental Protection Agency has also recently concluded that glyphosate is not carcinogenic.

These differences in approach can largely be explained by the hazard versus risk approaches of different agencies. In other words, the underlying questions asked are different, with the IARC assessing the likelihood that the chemical might cause cancer in humans, while EFSA studies “whether there is sufficient confidence that a pesticide, when used according to the conditions of its approval (i.e. exposure patterns), will not pose an unacceptable risk to human health or the environment.” In other words, while the IARC determines whether there is sufficient evidence to link a particular substance to a higher incidence of cancer, EFSA’s brief is to determine the definition of “acceptable risk” rather than seeking definitive proof of safety (which is scientifically impossible).⁶

Following release of the EFSA report, a group of 96 leading scientists sent a letter to the European Commissioner for Health and Food Safety, objecting to the EFSA decision on the grounds that the IARC had assessed evidence that was in the public domain and available to independent scientists to review, while the renewal assessment report provided to EFSA by the German Federal Institute for Risk Assessment (BfR) was partially based upon confidential studies conducted by industry groups which were not available to IARC to review. EFSA was also accused of using inappropriate criteria to

⁵ A category that also includes eating red meat, shift work, ingested nitrates and nitrites and many chemicals.

⁶ The sheer number of products on the market using glyphosate is beyond the capacity of any single agency to test, particularly as compounds such as Roundup can also include toxic additives, such as the surfactant POEA, or produce unexpected effects due to interactions between chemicals.

dismiss positively correlative data. The letter further argued that while IARC had carefully evaluated the strength and weakness of each study assessed, weighted findings according to quality of the data, and clearly identified all studies considered; the BfR study provided no justification for their findings, all citations having been redacted from their report. Moreover, the determination of “no unequivocal evidence” was misleading, as IARC’s determination of “sufficient evidence” in the animal and mechanical data indicates that a causal relationship has been definitively established.⁷ The letter concluded that EFSA’s evaluation did not, therefore, “reflect the available science” and should be disregarded.

Although EFSA did not categorize glyphosate as a possible or probable carcinogen, it still recommended restricting its use. Sweden, France and the Netherlands requested that the licence not be renewed. Several meetings of the EU member states failed to reach a qualified majority to either renew or refuse approval by the deadline of 30th of June, and the EU commission instead extended the current license for a further 18 months to allow another EU agency, the European Chemicals Agency (ECHA), to complete its own review.



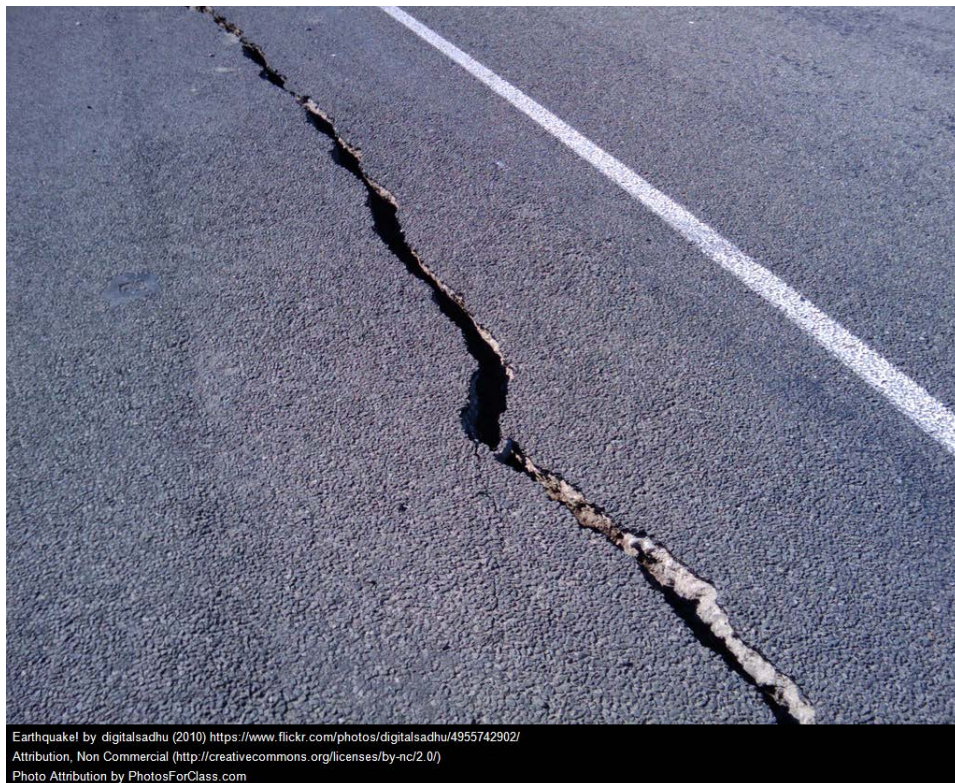
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⁷ The letter points out that in terms of public health evaluations, ‘limited evidence’ in the human data does not mean that the risk is negligible, but rather that causality is, while not unequivocal, credible enough to warrant concern.

INGSA CASE STUDIES

TERREMOTIA: FOLK KNOWLEDGE AND THE UNDERSTANDING OF RISK

Tatjana Buklijas (INGSA/University of Auckland)



TERREMOTIA

FOLK KNOWLEDGE AND THE UNDERSTANDING OF RISK

Background and context

Terremotia is a parliamentary democracy with market economy. It is classified as a high-income country with upper middle to high rankings in indicators such as quality of life, media freedom, education and literacy. Education is compulsory for children aged 6 to 16. Terremotia's economy relies mainly on agriculture (forestry, fishing, dairy, cattle and wine) and mining, with tourism rapidly gaining importance. It has a population of 12 million and its largest city is the commercial centre, Mercator de Terremotia, with the population of 2.5 million, followed by the capital, Villa de Terremotia with a population of 1.8 million.

Terremotia occupies a large territory of varied landscape. While the landscape attracts international tourists, it is also characterized by high volcanic and seismic activity. Terremotia experiences one to two magnitude 6 earthquakes/year, one earthquake of magnitude 7 every 5 years and one of magnitude 8 or more every century. While the capital Villa de Terremotia is located in the area of high seismic activity, the business centre, Mercator de Terremotia, is situated in the area considered to have a low seismic risk. No earthquake of any magnitude has been recorded there in the last century.

From early age, Terremotians are educated to prepare for and protect themselves in earthquakes, through drills at schools, workplaces, information in newspapers, TV and other media channels. The central institution uniting research into earth sciences with a system of monitoring and planning for earthquakes is the National Geological Institute (NGI). Recently, NGI has set up TerraNet, a geological hazard monitoring system, comprising a network of geophysical instruments, software applications, and staff whose job is to detect, analyse and respond to earthquakes, volcanic activity, landslides, tsunamis, as well as processes preceding large earthquakes. TerraNet also runs a public interface to ensure good communication of natural hazards and related risks to Terremotians. Overall, Terremotia is considered to be well served regarding both earthquake science, with many internationally recognised scientists working at NGI, and its platforms for the communication of earthquake and volcanic eruption risk.

Problem

At 4.35 am on 4 December 2016, which happened to coincide with a full moon, a magnitude 6.7 earthquake struck about 30 kilometres west of Mercator de Terremotia, at a relatively shallow depth. The quake was caused by movement along a previously unrecognised minor fault line that had not been mapped. The fault line lies deep under alluvial soils laid down by a river coming out of a large mountain chain. The earthquake caused significant building damage to the city, especially to old masonry buildings, but no direct fatalities. In the subsequent months, many smaller aftershocks (generally < magnitude 4) followed.

Despite Terremotia's long history of earthquakes, good science and monitoring systems, the "Mercator earthquake" and its aftershocks caught everyone by surprise because the city had not been considered to be at high risk. The surprise opened the space for speculation, in which astrologers, psychics and other "alternative forecasters" moved in. Using social media platforms, such as YouTube channels and Facebook pages, these forecasters attracted dedicated followers. Some of them claimed that the earthquake was due to the full moon and predicted another and much larger earthquake in or near Mercator, would happen one day when other astrological features would be aligned to cause a "greater pull".

At the same time, scientists at NGI were providing updated information about risk of further earthquakes, the location and strength of aftershocks, as well as more detailed information about the type and features of earthquakes. They were using national TV, radio, newspapers, web-based channels, and giving public talks in schools, community halls and other places. In spite of their work, there was much appetite for "alternative" information, which the media delightedly promoted.

This all was happening in an atmosphere of pessimism and economic downturn. Although Terremotia had recovered from the effects of 2008 global financial crisis, the falling demand for the ore from its mines had a negative impact on employment and economy. There were growing fears that tourism would suffer because of earthquakes. Mercator Airport is the largest and busiest airport in Terremotia and its harbour an important hub for cruises, and the bookings are already dropping.

In April 2017, a local radio station aired a weekly programme in which a media celebrity Simon Forman predicted a much bigger earthquake would happen in the next few days. Forman had more authority than other "alternative forecasters", because he had long been known as the author and advocate of an "alternative weather" model and had a regular "alternative science" programme, focused on subjects such as astrology, on the radio. Forman maintains a subscription-based website through which he sells weather forecasts, consults businesses and publishes annual weather almanacs. He has an audience among farmers in his own province (close to Mercator) and among recreational fishermen.

Two days after Forman's radio show and his prediction, a strong earthquake (Magnitude 7.3) struck some 200 kilometres north of Mercator. It was mostly felt in the sparsely populated mountainous pastoral area bordered by a national park. The epicentre was in the area of known high earthquake risk: ruptures along several fault lines were observed, including some previously unknown ones. While again there were no human victims, and the infrastructural damage mostly affected regional roads, the earthquake dislocated hills, river and sea bed by several metres

The apparently successful prediction earned Forman major media attention. Major newspapers, TV, online media all give him space to discuss his model and communicate predictions. On 20 July he tweets a prediction of a major earthquake close to Mercator "around the full moon on 1 August". The earthquake, according to him, will be much worse than either of the large preceding ones and it is likely to cause large loss of life.

Forman's prediction attracts huge media attention. On 22 July he is invited to a high-profile talk-show. The popular interviewer tries to counter Forman's claims but his manner is perceived as aggressive and, contrary to the plans, Forman is perceived a sympathetic figure. Some public

personalities are now pointing to a study, published in *Nature* just a few weeks earlier, according to which tidal stresses can exert additional strain on geological faults and trigger small earthquakes. The full Moon on 1 August also coincides with the Moon's closest approach to earth (perigee). Scientists at TerraNet however state that the risk of earthquake is not increased. Many citizens of Mercator decide to leave the city ahead of the predicted earthquake and a sense of panic is emerging. The financial centre of the country is essentially shutting down. There is a huge public pressure on the government to order evacuation.

"I am not trying to undermine TerraNet" says the mayor of Mercator, who has background in economics, "But their modelling shows that following the Mercator Earthquake of December the risk remains increased for a while, even a year. We had another big earthquake not so far in the meantime. What if the next one does strike when Forman predicted?"

The Prime Minister is calling the science advisor to help with the assessment of available evidence regarding the risk: should he try and stop the evacuation or not, and if so how to manage the public perception of risk and science communication.



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INGSA CASE STUDIES

UNITED MICROBIAN STATES

Antimicrobial resistance: responding to a global ‘slow burn’ problem

Context

Microbia is a federated democratic republic with a strong tradition of egalitarianism and a commitment to social justice that is reflected in, publicly accessible education and health care systems. The President of Microbia is the head of state while the Prime Minister is the head of government. The federal parliament is bi-cameral consisting of a Chamber of Members elected by proportional representation and a Senate appointed by the President.

The standard of living in Microbia is generally high, although economic disparities are growing as the country struggles to maintain its strong social programs. The manufacturing sector of the economy has eroded in the past generation, and Microbia has so far been unable to diversify and to curb rising unemployment, which some say is partly to blame for the demise of small former-manufacturing towns, many of which are in the midst of a complex opioid crisis. Microbia’s agricultural sector has remained a stable, due in part to the industrialisation of dairy in the last 20 years, in order to remain competitive.

Microbia’s few large cities are spread across the country. They are culturally diverse and relatively safe. Many urbanites are skilled migrants who maintain connections to their diaspora around the world. The two major federal political parties largely reflect this rural/urban split. The ‘Progressive Democrats’, who have a voter base that tends to be urban and well-educated, have formed a majority government elected on the promise of economic growth through innovation, for which nascent biotech and renewable energy start-ups seem to hold the most promise. The opposition ‘Microbian Alliance’ enjoys strong support from suburban and rural communities and tends to be more socially conservative than the PDs. Similar political divisions are reflected at the sub-national level within states, which have responsibility for education, health care, and environmental protection.

Antibiotic resistance in Microbia

Microbia, like most countries, has struggled to mount an effective public health response to the growing global problem of antibiotic resistance¹. Little is known about which sector in Microbia – health care or agriculture – contributes more to causing resistant infections in humans. Moreover, few new drugs are likely to become available in the immediate future as Microbia has no pharmaceutical companies at scale, and companies globally have reduced their research and development capacity over the last 15-20 years.

AMR consistently ranks high among priority issues for state-level Ministries of Health in Microbia, but it never seems to attract any concerted action. At the same time, states are facing a growing opioid overdose crisis, which has captured public attention and fuelled concern over increasingly long wait times in the country's overburdened emergency rooms. Regional hospitals are bearing the largest burden due to chronic understaffing and a high-needs population, which comprises an older demographic and increased numbers of unemployed – the latter commonly linked with opioid use. In urban centres, the opioid crisis is disproportionately affecting the indigenous population. Most Microbian cities are also dealing with a growing homelessness and precarious housing crisis as rents and house prices soar.

The Scenario

A few weeks ago, the Prime Minister revealed that her 11-year-old daughter had been admitted to hospital for an infected blister. The infection had spread to her bloodstream and was not responding to standard antibiotics. It took a week to identify the infection pathogen and to establish its susceptibility profile to available antibiotics. The girl was kept in an induced coma in intensive care. She recovered but only after treatment with a last-line antibiotic drugs.

The had campaigned on the promise to help states reduce ER waiting times and to increase access to health care, especially for rural Microbians. Now some commentators are suggesting the recent experience of the PM's daughter is an opportunity to raise the profile of AMR. The PM has struck a task team of Federal Health Sector officials to help her prepare for the upcoming State Leaders' conference, of which a focus will be health care.

Small group discussion

The PM's task team comprises the following members:

- Chief Scientist of the National Public Health Agency (NaPHA)
- Director of the National Pharmaceutical Authority (NaPharm)

¹ Antibiotic resistance occurs when bacteria no longer respond to the drugs designed to kill them. Resistance represents a major health and economic burden on healthcare systems and is expected to get worse over time, with projected cumulative economic impacts as high as USD\$100 trillion globally by 2050. Without effective antibiotics, there is a very real possibility that not only will we not be able to treat infectious disease but that medical care as we know it, like simple surgeries or cancer chemotherapy, could become too dangerous to perform.

- Head of State Liaison Office of the Ministry of Health (SLO)
- President of the Microbian Medical Association (USMMA)
- The PM's Chief of Staff is also participating in the meeting in order to prepare the briefing note for the PM ahead of the State Leaders' conference.

The task team is told only that the PM wants to "update her sense of health sector priorities" ahead of the State Leaders' conference.

She is relying on collective wisdom and expertise of the task team to help prioritise as there is insufficient time to commission full reports.

Character Outlines

Chief Scientist of the National Public Health Agency (NaPHA)

For years, you have been trying to make the case for a serious response to AMR, but the consequences are too abstract or too distant to capture public and policy maker attention. You have long felt it is a ticking time bomb, however. In fact, this is your number one priority and you want to seize the moment that has been created by the PM's personal experience with her daughter's illness, despite advice from colleagues that this will politicise the issue and could backfire. Quite the contrary, you think that Microbia has the opportunity to be a global leader in demonstrating the concerted response needed to deal with AMR and recent events provide just the right leverage. You want to see the country's doctors change their prescribing practices and become leaders in public education on AMR. To you, doctors play the biggest role in the issue and there can lead on the solution.

You know the opioid crisis is acute and needs attention, but the window of opportunity on AMR is too good to ignore.

President of the Microbian Medical Association (USMMA)

You see a major opportunity in the PM's daughter's recent health scare. There is no better time to raise the issue of AMR! You are determined to seize this moment. You want to see more research and development for better antibiotics, but – importantly – you want to see major restrictions on agricultural use of antibiotics. You firmly believe that Microbia's dairy sector is at the heart of the problem and states have refused to do anything about it. Only the PM can compel action and now is the perfect moment.

Head of State Liaison Office of the Ministry of Health (SLO)

You know better than most that State leaders are losing patience with the federal government! They will be demanding immediate action on access to care and an end to ER wait times. The opioid crisis is growing and people are dying of overdoses daily.

At the same time, state officials, working with mayors to address the housing crisis, have discovered some appalling living conditions among their cities' poor. You know there will be no appetite to address AMR at this stage. States have more immediate problems on their hands.

Director of the National Pharmaceutical Authority (NaPharm)

You know that if the PM wants to address AMR it will require you to confront state officials on antibiotic use and discuss regulation. But your mandate does not allow you to investigate agriculture.

The opioid crisis is also high on your radar. Everyone suspects doctor prescription practices are at fault, but new generation drugs make dosages tricky to manage as well, and now criminal operators are taking advantage of the ready market.

Media commentators are blaming you for having dropped the ball on this issue, with insufficient guidance to practitioners. You do not accept this criticism, but you know you must show leadership if attention turns here.

Meantime, the PM's previous healthcare priorities were safely out of your hands: access to care and wait times.

The PM's Chief of Staff

You have the best insight into the PM's motivations and aspirations. While her daughter's ordeal has clearly affected her, you believe that it will be a political disaster if a personal crisis is seen to redirect her attention on policy matters. She cannot risk her relationships with the State Leaders, with whom she currently shares good political alignment. They want action on their most pressing needs.

At the same time, you are mindful of the Microbia's international reputation, especially as the country is trying to attract highly qualified personnel to lift research and innovation. You worry that drawing attention to the opioid issue will jeopardise Microbia's reputation. You want the PM to have an opportunity to demonstrate leadership internationally.

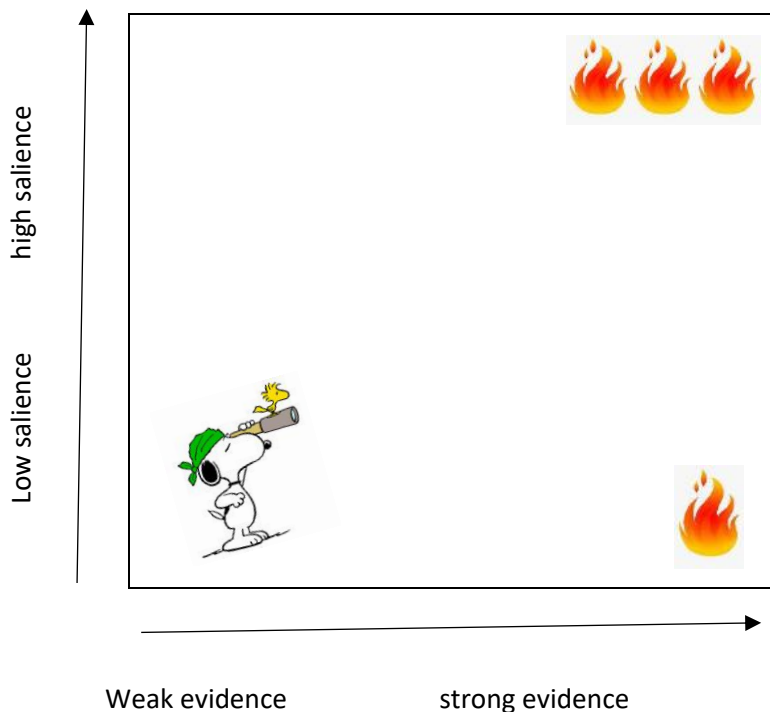
Mentor Notes (not for distribution)

Setting priorities, dealing with timescales, seizing opportunities...

Considerations for workshop mentors

All of you will have your own experience and wisdom to share about how policy agendas come about. These notes are just to get the discussion going.

At issue are the slow burning policy problems are those for which the evidence is settled but the public profile (i.e.: prominence or salience) is low. There is little incentive for action. By way of heuristic, we have tried to illustrate this issue using the scatter plot formulation below (note: we have refrained from a classic 2X2 because many problems will not occur neatly in a single quadrant).



Sample policy problems

- AMR
- micro-plastics
- sexual health
- sea level rise
- low carbon transitions
- anti-vaxxers
- tobacco control
- girls in STEM
- water fluoridation
- retirement age
- Universal basic income
- fish quotas
- freshwater quality
- Rare diseases
- invasive species

Think about the list of sample (random!) policy problems. Where would each one be positioned on the plot? Does their positioning correspond to the policy and public attention they receive? Why or why not? What other factors come into play?

In setting a policy agenda, policy and decision makers would ideally focus on the right-hand side of the plot (strong evidence) but this is not always the case. Referring to the position on the plot, some considerations might include:

- **Problems in the upper half** (high salience) can monopolise attention, regardless of evidence;

- Problems in the **upper-right** may be the ‘easy wins’ for policy action because evidence and salience aligns. However, depending on the trade-offs at stake, there may be active effort to keep the evidence from mounting, thus the axes are not independent but may modulate each other.
- Problems in the **upper-left** may be at risk of adverse selection and misguided action with long-term consequences
- **Problems in the lower half** (low salience) may seem easier for policy makers to ignore
 - Problems in the **lower-left** may seem like non-starters, but what is the state of the evidence? Why is it low? Are there signals to which we should be paying attention? This is the domain of horizon-scanning and foresight. What are the signs or combinations of signs that are tell-tale?
 - Problems in the **lower-right** are the SLOW-BURNING issues. What will move them to the upper-right to compel action?

Turning up the heat on slow-burning problems

Theories of ‘Policy Change’ have themselves changed over the years. From a dominant paradigm that emphasised rationalist interpretation and utility maximisation as drivers of policy, there is now greater understanding of a greater range of policy drivers

Depending on the theory, focus may be on very different factors:

- endogenous or exogenous factors (often thought of as external shocks or internal shifts over time);
- structural or human factors (ideational, behavioural...);

One common theory of change considers multiple interacting factors, but also requires the action of policy actors to make things happen. This ‘Multiple Streams’ theory (Kingdon 1998) suggests that three conditions are necessary for policy change to occur:

1. Problem – there is a problem that is recognised and agreed (salience)
2. Policy – there is a viable policy solution available
3. Politics – there is political will to take action

When these ‘streams’ converge or are made to converge through the work of a policy actor (‘policy entrepreneur’), it is a window of opportunity for policy change.

Discussion questions

How can an understanding of ‘multiple streams’ help to move problems onto the policy agenda (the upper-right quadrant of our plot)?

What factors tend to prevent problems from moving onto the policy agenda? Some elements for discussion include:

- No political momentum
 - o Perceived as cost driver
 - o 'Don't rock the boat'
 - o Avoid 'doom and gloom'
- No ready solution
 - o Industry not stepping in (market failure)
 - o Policy intervention is unclear (Incentivise? Regulate? Educate?... whom? At what level?)
- Structural barriers:
 - o Cost-benefit analysis doesn't support it
 - o Jurisdictional mandates constrain action
 - o Prioritisation process is limited
- Framing
 - o Is it a population health issue?
 - o Individual behavioural?
 - o Environmental?
 - o Food system?
- Perceived threat
 - o Who is at risk?
 - o No immediate risk
 - o If threat is not immediate and the timeline is uncertain
 - o No counterfactual information

Group Discussion Exercise

Understanding policy agenda setting and looking specifically at slow-burning issues is a new focus for an INGSA workshop. It is also considerably shorter than most of our workshops where there is time to work through a game in phases and with wildcard scenarios on more immediate problems and controversies.

For these reasons, we are taking a modified and modest approach of a structured discussion rather than a full role-play game. Still, we want the participants to get a sense of the tensions by introducing roles and their individual perspectives and interests, if only by way of conversation starter.

Goals for the discussion:

- Understand the tensions in identifying and prioritising policy problems
 - o How the problem is framed matters
 - o Different actors will have different degrees of influence
 - o Understand how evidence and salience can be mutually influencing
 - o Understand how the issues in the scenario might be placed (or move) in the 'plot' diagram as a heuristic.
- Understand what can influence policy action
- The Multiple Streams Theory can help to structure these conversations.



SUFFICIENCY OF EVIDENCE CASE STUDIES

The International Network for Government Science Advice

INGSA CASE STUDIES

OSTAL: WASTE, LAND USE AND TECHNOLOGICAL DEVELOPMENT A SUFFICIENCY OF EVIDENCE CASE

Dr Tatjana Buklijas, INGSA/University of Auckland



OSTAL

WASTE, LAND USE AND TECHNOLOGICAL DEVELOPMENT A SUFFICIENCY OF EVIDENCE CASE

Ostal is a large, developing country that after decades of civil war, instability, natural catastrophes and famine has now enjoyed a decade and half of peace, which in turn has fostered economic development and establishment of political institutions. Ostal's population is growing at 2.6% per annum and much of the population growth is located in the cities: the federal capital Magali that has nearly 4 million citizens but also provincial centres. Yet urban planning including residential building, utilities and infrastructure have not kept up with the rapid growth and economic development. Only half of the trash produced by the residents of Magali is collected while the rest accumulates in ditches, clogging the drainage and creating breeding pools for malaria mosquitoes. Waste collected in canals, streams and rivers is washed out to the sea and accumulates on beaches; piles of trash on street corners attract rodents. The waste that is collected is either incinerated out in the open (creating dangerous toxic fumes) or sent to landfills that are not well managed. In particular the major site once on the outskirts of Magali has now, through urban expansion, found itself surrounded by human settlement. Although official health statistics is lacking, there are reports of significant health effects suffered by people living in slums around Magali's largest dump site – proclaimed 'filled to capacity' in 2002 but still operating - who live from scavenging and selling useable waste to recyclers.

You are the Minister of Energy and Environment in the recently (democratically) elected government. You are determined to not only implement practical solutions that will tackle the problem of waste disposal, but also establish Ostal as the regional leader in environmental stewardship: from waste disposal to policies that will reverse the trend of the growth of greenhouse gases. Indeed Ostal was the leader in banning some of the forms of plastic materials and you are currently chairing the regional environmental association, ActionEnvironment. At the same time, the growing population and industry need much more energy than what is currently produced. The country largely relies on a few hydroelectric plants but the energy produced is both unreliable and insufficient. Solar panels have started to appear and there are some proposals to use geothermal energy but the lack of means to store solar power and the cost of using geothermal sources mean that these sources are used only in a limited fashion and cannot provide secure energy supply required in particular by industry and infrastructure.

SCENARIO



EVENT 1 – DAY 1

A young scientist & entrepreneur of Ostali heritage, with a PhD in Chemical Engineering from a leading German university, has approached you with a proposal to build an industrial plant that would turn the heat generated by burning the waste into electrical energy. He has a partnership with a major international company who have experience in building similar types of plants. They promise that the plant will produce 25% of electrical energy currently used in the country – provided that all the waste generated in Magali is directed to the new “waste-to-energy” plant. Waste incinerators using the heat generated either directly as heat or for electric energy have of course been used for a long time: in developed countries many are phased out because of the production of toxic gases (e.g. dioxins) and fine particles that have negative consequences for health, and also because waste is on average low in energy and hence inefficient fuel.

You have been assured that the new technology (developed during his postdoc years in Germany and Sweden) that will be implemented in the plant is able to capture 99% of toxic gases and turn them into inert materials. They accept that the waste is not as energy dense as fossil fuels however it is abundant, readily available and free.

Questions for Discussion

- **What is the problem you are trying to solve?**
- **What information is going to be required to make any of these decisions?**
- **How will you get this information?**



EVENT 2 – TWO MONTHS LATER

There has been considerable interest in the proposal among other members of the Cabinet. The entrepreneur and his international partner have come back with a fully costed plan. While they are providing technical know-how and support, there is considerable investment required on the part of Ostali government. Treasury has pointed out that there is no money in the budget. However the Minister of Development, Transport and Infrastructure suggested that there are funds budgeted for the development of new electrical energy sources: solar and geothermal, possibly also wind. They could be redirected towards the waste-to-energy plant.

This seems like a good idea although you argue that the exploration of other energy sources should not be dropped altogether but rather just postponed.

In the meantime the news about the proposed plan have found their way into the media. There is much excitement about the “local bright boy” finding a clean solution for Magali waste problems while providing Ostal with a stable source of electric energy. Everyone is in favour of the project: wealthier citizens of inner suburbs, who are excited about a solution to the trash, and those much poorer who live in the proximity of the landfill site and who have suffered the ill health effects. The only ones worried about it are those who make a living out of collecting and recycling trash. However the new plant promises to open new jobs and also there will be jobs managing the flow of waste into the so the net effect on employment should be acceptable.

Questions for Discussion

- **What is the problem you are trying to solve?**
- **What information is going to be required to make any of these decisions?**
- **How will you get this information?**



EVENT 3 – SIX MONTHS LATER

A contract with the consortium has been signed and preparatory work has begun. Although initially it was expected that the plant would be built on the old landfill, an engineering assessment has shown the site to be too unstable and the plant had to be moved elsewhere. The landfill site remains in its current form, requiring remediation, and the government had to spend further funds on the purchase of a suitable site: it is situated closer to residential developments but you are assured that that's not going to be a problem. Furthermore, although the consortium has initially promised to employ local workforce, detailed plans have shown that there are not enough trained workers so the international company has decided to recruit them overseas and bring them into the country just for the building stage.

While the construction is going on, you are travelling to a meeting of the ActionEnvironment (in a neighbouring country). You are asked many questions about the plant but the reception is cool. Other participants of the meeting see this as a step back in the environmental commitment. They see the plant as undermining sustainable, zero waste practices. The citizens of Ostal were producing relatively low (by international standards) amounts of waste: this plant seems to encourage them to produce more. And not only that, the plant diverts from practices of waste, reuse & recycle, entrenched in Ostali culture. Much of the waste, they point out, is organic and it would be much cheaper and more sustainable to build a municipal composting system. "There are many ways in which energy and waste are linked" said the representative of a neighbouring country, "but building an incinerator to produce electric energy is not a good way to think about it."

Questions for Discussion

- What is the problem you are trying to solve?
- What information is going to be required to make any of these decisions?
- How will you get this information?



EVENT 4 = TWO YEARS LATER

The plant was completed on schedule and it is in operation. There are some problems, though. For one thing, the plant requires specialized workforce and while the consortium promised to train up and employ local staff but that has happened only to a lesser extent. Most of the workers, especially engineers, are from overseas, though this is supposed to be just a temporary measure until the plant, in collaboration with Magali polytechnics, educate the workforce. Furthermore, full operation of the plant requires a steady delivery of waste. However the municipal collection system is not well set up for it. Trucks are not well maintained and often break down, collection dates and times change, people do not bring their waste to collection sites when requested. Some indeed take the waste to the old landfill, which remains an open dumpsite and a health hazard. The market in waste scavenging and recycling continues to operate. To make sure the plant can operate at full capacity and produce electricity as promised, the international partner has proposed to the government of Ostal to start importing soft plastic waste from overseas. The government could thus earn some cash while also ensuring a steady stream of fuel reaching the plant. This proposal has received mixed reception. Some people agree with this “sensible” proposal, which allows the plant to fulfil the promise of producing 25% of electric energy needed. Others are offended by the idea of Ostal becoming a “dumpsite of the developed world.”

Regarding the ability of technology to capture pollutants, it is working though not nearly at 99% (gases such as dioxins and furans are captured, but ultrafine particles, flue ash, not nearly as well). There is definitely an increase in air pollution around the plant and residents are occasionally complaining of the feeling of “burning” in their throats. Some are worried that, if this is happening now, when the plant is operating only intermittently, what sort of air will they be breathing in when the plant is operating at 100%.

Questions for Discussion

- What is the problem you are trying to solve?
- What information is going to be required to make any of these decisions?
- How will you get this information?



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INGSA CASE STUDIES

PANDERIA: WHEN PANDEMIC TURNS TO PANIC A SUFFICIENCY OF EVIDENCE CASE

INGSA/University of Auckland



PANDERIA

WHEN PANDEMIC TURNS TO PANIC

Panderia is a small, developing landlocked country surrounded by five countries, two of which, the larger Alterra and the smaller coastal Afristan, have been involved in violent conflict for over two years. Although relatively poor, Panderia has been receiving refugees from both countries. With the help of international aid agencies, Panderia has been able to accommodate tens of thousands fleeing Afristaners and Alterrans. However the life in the refugee camps is hard: there is barely enough food, living conditions are cramped, and access to washing facilities is limited. There have been a few outbreaks of gastroenteritis. While all of these outbreaks have been contained, they continue to appear with some regularity.

Recently news has come through of a new and potentially highly infectious disease that appeared in Afristan, provisionally named Afristan Respiratory Encephalitis (AFRE). AFRE is thought to have been originally transmitted to people from monkeys, and is now spreading through human-to-human transmission. The spread is likely occurring through droplets, as the disease starts with a respiratory infection; within 24 hours it becomes encephalitis, which is often fatal or leaves individuals with brain damage. Within a few days the affected person goes from full health to extensive and often frightening symptoms ranging from personality changes and hallucinations to muscle rigidity, involuntary spastic movements and seizures. The mortality is around 50%, although can vary from 25-90%, and about of third of those who survive are left with permanent neurological damage. Women seem to be affected more often, and worse, than men.

Community engagement is important to controlling outbreaks, through a package of interventions: case management, use of face masks, surveillance and contact tracing, a good laboratory service, safe burial practices and social mobilisation. Early supportive care with rehydration improves survival. But in the war-torn Afristan none of this is readily available. Panderia has instituted border checks, including medically trained staff at the busiest border crossings, to identify and quarantine infected people. However it is clear that this will not be enough: many are slipping past the border crossings, through the dense forest.

You are an experienced public health physician and a member of the Panderian Emergency Response Committee and you have just heard about a possible case of AFRE in Panderia.

SCENARIO



SITUATION CLOCK T = 0

You have received a phone call from the head of the Municipal Health Department in the capital of Panderia, Khale. A person has been brought to the main city hospital from the Afristan refugee camp, suffering with seizures. It is a middle-aged woman who lives in the refugee camp with her extended family. Health personnel at the camp initially diagnosed the illness as an untreated epilepsy but the hospital physicians now suspect it to be the first case of AFRE in Panderia. The patient has now been quarantined in the hospital infectious disease ward though it is not 100% it is indeed AFRE.

Questions for Discussion

- What is the problem you are trying to solve?
- What are your options?
- What information is going to be required to make any of these decisions?
- How will you get this information?
- What action, if anything, will you take?



SITUATION CLOCK T = 12 HOURS

The medical staff at the hospital and health workers in the refugee camp have been requested to keep confidentiality, but within the hours of the admission the news about the possible case of AFRE has trickled onto social media. A person visiting a family member at the hospital ward adjacent to the infectious diseases has noticed the commotion and surreptitiously filmed quarantining of the suspected victim. Although the film provided no definitive link between the quarantined person and the refugee camp, the YouTube video was shared widely: in Panderia, especially among those who reject Panderian current politics towards refugees, but also worldwide – by conspiracy websites, sensationalist press, and in political circles that favour isolationist politics or oppose Panderian politics of neutrality. On Twitter and Facebook too the rumours of the epidemic spreading to Panderia (#HushedAFRE).

Questions for Discussion

- **What is the problem you are trying to solve?**
- **What are your options?**
- **What information is going to be required to make any of these decisions?**
- **How will you get this information?**
- **What action, if anything, will you take?**



SITUATION CLOCK T = 3 DAYS

The Khale public health authorities have demanded an investigation into the background and connections of the patient. The camp authorities have now confirmed that she has been in the camp for a month prior to the symptoms exhibiting. She is 44 and had arrived into the camp from Alterra with her five children and a grandchild, a baby daughter of her eldest daughter who had been killed in the conflict. In the camp she joined members of her extended family and friends from her hometown. She has had close contact with dozens of people.

In the meantime the first laboratory results have arrived and they are inconclusive. There is a high titre of antibodies that can also be found in certain autoimmune conditions. The patient no longer has seizures but now she is experiencing mental confusion and hallucinations. The diagnosis remains open.

In social media as well as tabloid press in Panderia and its neighbours (as well as the British *Daily Mail*), the rumours are continuing to spread. The opposition party are demanding answers from the PM of Panderia. She happens to be out of the country attending an international conference attempting to broker a peace agreement between Afristan and Alterra. The PM is internationally regarded as the peacemaker of the region. Yet critics are arguing that, by accepting refugees, she is exposing her own population to danger. Her motives are not at all selfless, they say: she wants to earn international respect in order to pave the way to a high-level position in an international organization following her career in Panderian politics – which is, they say, likely to end soon.

Questions for Discussion

- What is the problem you are trying to solve?
- What are your options?
- What information is going to be required to make any of these decisions?
- How will you get this information?
- What action, if anything, will you take?



SITUATION CLOCK T = 2 WEEKS

The virus culture arrived and it shows no AFRE in the blood. A medical delegation from the Centre for Disease Control has arrived in Panderia. The team that included Panderian infectious disease specialists has arrived to the conclusion that the symptoms are a result of a combination of underlying issues. These include an untreated autoimmune disease; a longstanding parasitic infestation which has now become active following the physical and mental exhaustion of the war, long journey and life in the camp. With the good care and medical treatment she has now recovered sufficiently to be discharged.

Yet the camp authorities worry that she cannot go back to the original camp. Although the diagnosis has been publicized and the public has been told that there is no reason to worry, the rumours are continuing to circulate, and the original video continues to be shared. The PM has returned from overseas and has appeared on national TV to soothe the public. Yet even though many accept that this was indeed not AFRE, they continue to worry that this case has shown that it is only a matter of time until AFRE is indeed going to arrive in Panderia.

There has been a sharp increase of attacks on the refugee camps, to the extent that Panderian army has been called to protect the camp. The mood in Khale is tense.

Five days ago, a rumour began to circulate on social media that drinking hot water with considerable amounts of added salt could prevent AFRE. Already, excessive salt consumption in the summer heat has led to several hospitalizations and one death.

Some are turning to traditional healers in a bid to combat the disease through prayers and exorcisms, rather than medical science. Also, unscrupulous merchants are selling “AFRE vaccines” at extortionate rates, made of little more than limes and onions.

Questions for Discussion

- **What is the problem you are trying to solve?**
- **What are your options?**
- **What information is going to be required to make any of these decisions?**
- **How will you get this information?**
- **What action, if anything, will you take?**



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INGSA CASE STUDIES

VASCOVY – PANIC AT THE BORDER

Emergency Response – Risk and uncertainty in a digital age

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VASCOVY – PANIC AT THE BORDER

Emergency Response – Risk and Uncertainty in a digital age

Background and context

Vascovy is an advanced democratic republic of about 10 million people, centrally located in its region. Its ruling party is seen as centrist with vocal parties to both the left and right in opposition. Its geography, with good harbours on its north-west coast, means that it is a transit and logistics point for a number of neighbouring landlocked countries with a collective population of about 60 million.

The country's capital, Monserrat, is located inland on the junction of two rivers and located close to the western border with the country's larger neighbour, Graznavia. Graznavia has a population of ~25 million but whose economy has been faltering under a nationalist populist government that is sometimes described as near-fascist in Vascovy's rather free press.

While there are considerable historical tensions between Vascovy and Graznavia dating back over 200 years, relating to differing languages and religious history, the Government of Vascovy has been courting Graznavia due to their growing role as an energy producer. Recently, in a token diplomatic gesture, Graznavia agreed to support Vascovy's campaign for a seat on the UN Security Council.

Currently, Vascovy imports the majority of its energy from Energia, another country on the other side of the gulf with extensive nuclear capacity and some hydroelectric resources, via a 70 km undersea cable, resulting in high energy prices. The Vascovian Government is keen to diversify their energy sources, for energy security and because lowering citizen's energy prices is an important political issue.

While relations with Energia have in the past been very good, political and populist change in Energia is leading to rumors, which have not been refuted, that Energia will increase their pricing of exported energy by 35% when the current supply contract to Vascovy expires in 2 years' time.

Graznavia has recently expanded their energy production capacity by upgrading and expanding an aging nuclear power plant close to the border with Vascovy and within 50 kilometers of Vascovy's capital. They are keen to sell surplus energy to Vascovy. Opponents in Vascovy have attacked the government, accusing them of not exerting enough pressure on Graznavia to build the new reactors elsewhere, in exchange for a favourable deal on energy imports.

Elements of the public, including a growing environmentalist party and a small but growing ultra-nationalist fringe, object to buying energy from Graznavia, the former because of their anti-nuclear stance and the latter because Graznavia is seen as untrustworthy and Vascovy should not be reliant on their historical enemy.

The regional power, Norvenia – with a population of 140 million and authoritarian rule – is also suspected of using digital platforms to whip up dissent amongst protesters in Vascovy. Some protests have been violent, with injuries but no deaths. Tear gas has had to be employed on several occasions. It is suggested that the Norvenian government stands to lose influence in the region if Vascovy and Graznavia form stronger ties.

Many of the countries in the region are signatories to the Regional Union Agreement (RUA), a transnational grouping that primarily exists as a block on Norvenian influence. Geo-politically, Graznavia is an important member of the group, but is also the most likely to disagree with the other heads of state, and is the 'difficult sibling' of the RUA.

Even so, Norvenia still exercises considerable influence and power in the region and has been running military exercises with Graznavia close to the Vascovian border. This has caused the relationship between Vascovy and Graznavia to sour once again and has culminated in the Vascovians recalling their ambassador from Graznavia. Tensions in the region are heightened.

You are a member of the Vascovian government's Emergency Response Committee and social media has just lit up with news from just across the border.

SCENARIO



Situation Clock T = 0

Facebook shows images of smoke billowing into the air; shaky video of a Graznavian farmer pointing at the plume on the horizon, sitting low over the trees. The key words you can pick out are 'explosion' and 'nuclear plant'. In the background, some people are seen running towards the situations; others are running away. The video is going viral. Other videos of questionable authenticity follow.

Media outlets around the world are reporting on the video even though there is no consensus on what has happened. There is no immediate response from the Graznavian media or government.

Then the International Atomic Energy Agency (IAEA) releases an announcement that their local monitoring equipment has detected a spike in radionuclides in the region around the new Graznavian reactor. The dose is low but the IAEA indicate that it is consistent with the first stages of a nuclear event.

The Prime Minister of Vascovy calls together the Emergency Response Committee, of which you are a member, demanding advice.

Questions for Discussion

- **What is the problem you are trying to solve?**
- **What are the actions – reactive or pre-emptive – that you should be considering?**
- **What information is going to be required to make any of these decisions? How will you get this information?**



Situation Clock T = 4 Hours

The eyes of the world are now on Graznavia and the government has moved fast to officially deny that there is any ongoing danger.

In an official statement, the Prime Minister of Graznavia has stated that there was a minor, non-critical, event at the new reactor during a training exercise. The event was immediately handled according to protocols and was successfully contained. While there was a minor leak from a cooling pipe, the dosage was well below any harmful level, even to the workers in the plant, and there is no risk of contamination of groundwater or further radiation leaks.

The minor nature and swift containment of the event was proof, the Prime Minister said, of the effectiveness of the safety systems in place, and therefore Graznavia was fully competent to manage it on its own. They would not be allowing external assistance or oversight. A detailed report would be released once a full evaluation was done.

With the Vascovian government having recalled their ambassador, the *chargé d'affaires* has little direct access to Graznavian officials – his request by email and phone for further information is dismissed by the Graznavian foreign and energy ministries with referrals to the Prime Minister's previous announcement.

In Graznavia, the political Opposition party – who have traditionally been resistant to nuclear power – have responded with a press release saying the government had repeatedly been warned about the vulnerability of the Graznavian plant to terrorism. They have re-released their report on the risk and are getting a lot of traction.

CNN is now reporting from the outskirts of the nuclear facility, barred from getting too close by the Graznavian army. Their footage shows that smoke is still rising from the facility, fueling more suspicion of the government's statement that the situation was contained. CNN have also captured images of a number of ambulances leaving the site.

Across social media, comparisons with Chernobyl are at fever pitch, with #GraznaviaChernobyl the number one hashtag globally.

In Monserrat, protests are quickly forming, a mix of panicked citizens, driven by both green groups and ultra-nationalists. As well as shouting for a response from the Vascovian government, the ultra-nationalists are demanding an immediate closure of the border to stop people fleeing from Graznavia.

Roads out of the Monserrat are clogged with people trying to escape to the coast – a major traffic jam has formed at the motorway bridge over the Monserrat river and there is a growing sense of panic. When a car breaks down blocking one lane of the bridge, angry people use a truck to push it over the parapet into the river.

Questions for Discussion

- **What is the problem you are trying to solve now?**
- **What information, and from whom, do you need to assist you?**
- **What measures need to be put in place?**



Situation Clock T = 8 Hours

A little known global eco-terrorist group has claimed responsibility for damage to the plant as part of a broader campaign against nuclear.

In contrast, social media, and some traditional media outlets, are reporting an unattributed comment from “a Graznavian official” that the event was due to a design flaw of the new reactor, and that a full meltdown could still happen and that full control over the reactor has not been restored. No one has been able to track the origin of this story.

In response, Energia, the country that supplies the majority of Vascovy’s energy, has announced that it will be shutting down its own nuclear reactors of a similar design, until a full evaluation is made. This immediately reduces Vascovy’s energy capacity by 40%.

Updated information from Graznavia is limited, except for constant reiterations that the situation is contained. The Graznavian President accuses his political opponents of fabricating information to provoke a crisis.

The Graznavian government has clamped down on social media platforms, to try and to regain control of the narrative. They have demanded that Vascovy do the same to assist with limiting the spread of panic.

The Vascovian Stock Market has plummeted 8.5% over the day’s trading and trading is halted, potentially heralding a full crash when the markets reopen. Protests in the capital have swelled and several Graznavians have been attacked in Monserrat.

Official information from the border is that there are growing numbers of Graznavians at the border seeking to cross but no incidents have been reported to the head of the border police. Yet over social media, there are unsubstantiated videos and reports of crossings being overrun and people flooding into the country, with vague reports of people having been killed by being trampled when Vascovian border guards shut the border. These reports are being retweeted by right-wing Vascovian nationalist groups.

The Rolling Stones were scheduled to play the next day in Monserrat but all public events have been cancelled. The band was rushed to the airport but the strain on airport infrastructure has resulted in many flights being unable to take off. It is no longer known where the band is, or if they have attempted to leave Vascovy by car instead.

The Prime Minister of Vascovy announces that he has spoken to the Prime Minister of Graznavia, and has convinced his counterpart to accept a team of international experts to inspect the site, including a Vascovian representative.

In truth, there was a great deal of resistance to having a Vascovian as part of the inspection team and negotiations have considerably delayed the process and the team is only now assembling.

QUESTIONS:

- **What is the problem you are trying to solve now?**
- **How has the information you require changed?**
- **What new measures are needed?**
- **What communications need to be considered?**



Situation Clock T = 12 Hours

Vascovian cybersecurity experts in the military detect a massive increase in denial of service attacks on Vascovian utility providers and banks. They believe they originate from Norvenia. Panic is spreading and so is anger.

A Facebook post that spreads rapidly purports that the Vascovian Prime Minister had arranged for a military helicopter to take his wife and children out of the country in the first hours after the explosion at the nuclear powerstation. The Prime Minister vehemently denies this but protests grow in Monserrat.

The inspection team gets consent to enter Graznavia using a civilian helicopter.

QUESTIONS:

- **What is the problem you are trying to solve now?**
- **How has the information you require changed?**
- **What new measures are needed?**
- **What communications need to be considered**



Situation Clock T = 24 Hours

The Vascovian Prime Minister and his wife are pictured visiting Vascovian internal refugees who have moved from the border and are camped in emergency shelters in the capital. The PM does a live press conference with his wife standing next to him.

The Vascovian government is notified by the IAEA that the inspection team finds radiation readings in the area of the plant to be only minimally above background levels.

CNN reports that a commercial satellite has taken images of the nuclear plant and have been able to identify that the explosion did indeed occur in a downstream, non-critical section of the plant, away from the core. These images have been televised by CNN and placed on their website.

The international team of experts, including the Vascovian representative, have confirmed the Graznavian government's version of the event – that a human error in managing the cooling pipe backup procedure did lead to an incident, but that the plant's emergency response, and the correct following of protocol by the plant employees, contained the issue and there was never a real risk of meltdown. It was not a design flaw.

Public panic starts to subside but there are still some violent protests against the Vascovian government's connection to the plant and some extremists accuse the Vascovian government of being complicit in the cover-up. This accusation is further fueled by an accusation on 4Chan that claims that the Vascovian Minister of Environment, a multimillionaire investment banker, was a secret investor in Energia's hydroelectric company and that that company had paid a workman to stage the accident to push up the price Energia could charge Vascovy for power.

These protesters are ignoring the reality that the Energia energy company is state owned with no private investors. The Prime Minister points this out and dismissed the allegation saying has full confidence in the Minister.

QUESTIONS:

- **What is the problem you are trying to solve now?**
- **What considerations need to be made for managing the post-crisis?**
- **How has the situation changed how you might consider relating to your neighbour in future?**
- **Are there changes in the relationship that could have averted the issue?**
- **What steps might you have taken at the start that would have made a difference to the outcome?**

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DUESBERG, MBEKI AND AZT: *Contentious science meets contentious politics*

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CASE STUDY VERSION: SEPTEMBER 2017



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DUESBERG, MBEKI AND AZT:

Contentious science meets contentious politics

The spread of human immunodeficiency virus (HIV) infection has been a major global health concern, particularly in developing countries that do not have the medical infrastructure to support increasing numbers of people with acquired immune deficiency syndrome (AIDS). In South Africa, there were several laudable attempts to combat the spread of HIV before the end of apartheid, but little agreement as to how to tackle the growing epidemic. Following the country's first democratic election in 1994, which led to Nelson R Mandela becoming President, the AIDS response was made a Presidential lead project in the Department of Health under the government's Reconstruction and Development Programme (RDP). When Thabo Mbeki assumed the reins of government in 1999 and the RDP was scrapped, the AIDS programme remained part of the Department of Health but was spread over several ministries and substantially changed.

Shortly after he became president, Mbeki expressed reservations about the use of antiretrovirals to prevent progression from HIV infection to full-blown AIDS. This led to a battle between SA AIDS activists and the African National Congress (ANC), with the former demanding distribution of the antiretroviral drug AZT to pregnant women to avert transmission of HIV to their children, and the ANC refusing on the grounds of expense. Mbeki, former chair of the Inter-Ministerial Committee (IMC) on AIDS and a follower of Peter Duesberg's controversial research claiming that HIV did not cause AIDS, changed the scope of the debate. Mbeki and his Health Minister, Manto Tshabalala-Msimang, sought to increase social involvement in prevention, but refused to provide antiretrovirals to those diagnosed as HIV-positive, even after the SA government won a lawsuit for the right to produce its own cheaper generics. Instead, they sought to promote 'African' remedies such as garlic and beetroot to prevent the onset of AIDS. This policy of 'denialism' that HIV was the cause of AIDS (leading to the conclusion that AZT treatment provided no benefits) did not significantly change until after the election of Jacob Zuma in 2009. It has since been estimated that over 300,000 lives may have been lost over that decade due to the lack of adequate care (Chigwedere et al. 2008).

Background and context

Azidothymidine (AZT, also known as Zidovudine or Retrovir) is an antiretroviral compound targeting HIV through a mechanism that inhibits replication of the virus. Originally synthesised by Jerome Horwitz in 1964 as a cancer drug, it was eventually patented by Burroughs Wellcome (now GlaxoSmithKline). In 1987, it was approved by the US Food and Drug Administration (FDA) for treatment of AIDS after only 25 months of development and one double-blind clinical trial. The trial showed that while the drug had toxic side effects, including bone marrow suppression that on occasion was severe enough to require transfusion (see Fischl et al. 1987; Richman et al. 1987), it could be briefly effective for some patients who could tolerate it. In the absence of any other treatment, patient groups, notably ACT-UP, demanded that the FDA fast-track the drug (Crimp 2011, Jonsen and Stryker 1993). Critics argued that the sample size in the AZT trial was too small, too many

patients had not completed the full treatment protocol, the data showed that any beneficial effects were short-lived at best, and in effect, the FDA had failed to distinguish between experimentation and therapy (Annas 1989). Subsequently, the AIDS Clinical Trials Group was established in the US, involving several thousand patients from asymptomatic to advanced, in a double-blind trial to determine protocols for antiretroviral drug use (Hirsch 1988). However, research into this time period of AIDS drug development has also shown that these so-called 'clean subjects', i.e. candidates who had not undergone any prior treatment, often hid their use of other medication and patients frequently exchanged their given doses in the hope of evening the odds of receiving the drug rather than the placebo (Epstein 1996). How effective AZT was, for whom, and in what dosage, was therefore still subject to some debate.

A few scientists were not even convinced that HIV was the cause of AIDS, leading to questions not only about the effectiveness of AZT, but about whether drug research was even targeting the correct mechanism of progression in the collection of rare diseases that manifest as AIDS. There is still a small community of dissent on this topic, mostly centred on the work of Peter Duesberg, a professor of molecular and cell biology based at the University of California Berkeley, with a distinguished career working on viral causes of cancer. In 1987, the same year as the Harvard trial, Duesberg published a key paper on cancer genetics in which he concluded that there was little evidence that the human T-cell leukemia virus (HTLV-III) identified by Robert Gallo in 1984 was the cause of AIDS (Duesberg 1987).¹ He argued that most people who had been exposed to HIV (determined through antibody testing) were not symptomatic and only 15% of AIDS patients tested positive for antibodies, that the levels of virus in symptomatic patients seemed too low to be clinically significant and that there were no genes within the virus itself which could cause the illnesses associated with AIDS. While agreeing that there might be some indirect correlation between the presence of HTLV antibodies and the possibility of developing AIDS, Duesberg claimed that exposure to the virus was not a sufficient cause by itself, and pointed to external factors which might affect the immune system and its ability to fight off opportunistic infection. In subsequent work, he has blamed the US/European epidemic on the immunosuppressive effects of recreational drugs and other 'risky' lifestyle behaviours, and on the widening use of 'toxic' antiretrovirals such as AZT at non-symptomatic stages of the disease (Duesberg and Rasnick 1998). Assessing Duesberg's claims through literature review and interviews with experts on both sides of the debate, the influential journal *Science* concluded that while Duesberg had raised 'provocative' questions, the weight of evidence suggested that HIV did indeed cause AIDS (Cohen 1994).

Duesberg has not been the only critic of the toxicity of AZT, and several influential studies of the time noted that the severity of the side effects, which included vomiting, headache and muscle pain as well as bone marrow failure, could negate any gain in lifespan for some patients (see, for example, Lenderking and Gelber 1994). Concorde, the largest double-blind study of symptom-free or early symptomatic HIV-positive adults, tracked 1749 participants for three years, with half using 1000mg of AZT per day. It concluded that AZT conferred 'no statistical difference' in improving symptoms or in halting progression, and argued against its use for symptom-free adults (Concorde

¹ The virus identified by Robert Gallo in 1984 as the cause of AIDS, which he named HTLV-III, is now known as HIV-1. Françoise Barré-Sinoussi and Luc Montagnier jointly received the Nobel Prize in 2008, having independently identified the same retrovirus under the name "lymphadenopathy-associated virus" in 1983 (Barré-Sinoussi *et al.* 1983).

1994). Other studies have shown that AZT is effective in much lower doses (200mg rather than the 1200mg per day used in the 1987 trial), and may be used in conjunction with other drugs in individually-tailored 'cocktails' which may avoid some of the side effects (Fischl et al. 1990).

While AZT was no longer the only antiretroviral option by the late 1990s, it was still considered by the mainstream AIDS community to have the best possibility to render AIDS a manageable chronic disease. And, in the case of pregnancy, to inhibit transmission of the virus from mother to child (Connor and Sperling 1994), although not without some risk of foetal abnormalities if administered before birth (Kumar et al. 1994). Anti-retrovirals, including AZT, administered to the mother during childbirth, and to the child for several weeks thereafter have had good success in reducing mother to child transmission of HIV (Connor and Sperling 1994), and US guidelines now encourage their use, even during pregnancy, to reduce overall viral load and maintain maternal health (NIH 2016).

The dilemma

The first reported South Africans to die of AIDS in the 1980s were white homosexual men. The first black patient not exposed through transfusion was diagnosed in 1987 (McNeil 2012), although it is likely the disease had been present in the population for some time. A statement written after the 4th International Conference on Health in Maputo (Mozambique) in 1990 noted that there were approximately 60,000 HIV-positive people in South Africa and these figures were expected to double every eight and a half months, meaning that southern Africa was now in 'an established epidemic' (Maputo 1990: 386). The National AIDS Convention in South Africa (NACOSA) produced a plan of action in 1992, but this did not include distribution of AZT (Ijsselmuiden et al. 1993). Although Nelson Mandela spoke at the convention (Mandela 1992), and the plan was adopted by the African National Congress (ANC) when he took office in March 1994, its implementation was hampered by the complexities of transition from an apartheid state. By then, HIV infection was estimated to have risen from 0.8% to 12.3% of the total population (Simelela and Venter 2014).² In the Mandela government, the AIDS programme was accorded the status of a Presidential lead programme as part of the RDP with its main base of operations in the Department of Health, but it was not seen as a key concern in the immediate post-apartheid era. Mandela himself did not become a strong leader in the fight against HIV/AIDS until after he left the Presidency in 1999.

Mandela was succeeded by his former deputy, Thabo Mbeki, an economist trained at the University of Sussex in the early 1960s while he was exiled from South Africa for being a leader of the ANC. Under Mandela, Mbeki had been largely responsible for the co-ordination of AIDS policy and has been characterised as a 'workaholic who sets himself impossible standards of trying to become an expert on every subject his government has to deal with' (Sparks 2003: 254). Mbeki encountered Duesberg's writing while self-educating about AIDS via the internet (Specter 2007) and thereafter became convinced that poverty, not HIV or sexual transmission, was to blame for the rising death toll due to AIDS. Taking office with a plan of liberating South Africa from reliance on donor agencies,

² However, it has also been noted that diagnosis at this time was often through observation, not antibody testing, and many of the symptoms ascribed to HIV are also symptoms of common diseases, such as malaria, making exact numbers difficult to verify. This also made it difficult to calculate AIDS mortality, as many such deaths were instead ascribed to related conditions such as tuberculosis, with no record of HIV status (Groenewald et al. 2005).

he then proceeded to staunchly reject the knowledge, programmes and arguments put forward by the international AIDS community about the best way to combat the spread of HIV.

The role of scientific advice

In 2000, Mbeki invited Duesberg, fellow molecular biologist David Rasnick and Harvey Bialy,³ general practitioner Sam Mhlongo, and several other 'AIDS dissidents' together with representatives from the mainstream AIDS community, the WHO and other agencies, to participate in a Presidential AIDS Advisory Panel. The final recommendations, which were not agreed to by all the members of the Panel, called into question the epidemiological statistics and suggested that the apparent increased mortality from AIDS might be due to other factors.

The report divided many of its recommendations into two competing suggestions, one provided by those who did not believe that HIV was the cause of AIDS, and another by those who did. The former group suggested that HIV infection should no longer be publicly spoken of as potentially fatal, and that all HIV testing should be suspended until a link was proven. On the use of antiretroviral drugs, the dissenters also claimed that Africans diagnosed as having AIDS would not fit the criteria in use in the USA, Europe and Australia, that AIDS was neither contagious nor sexually transmitted, and that the compromised immunological condition defined as AIDS was actually induced by poverty and the use of toxic anti-HIV drugs (Presidential AIDS Advisory Panel Report 2000). The dissenting views supported Mbeki's longstanding argument that even if the expense of AZT could be mitigated through donor programmes, the drug should not be distributed through the public health system (including programmes to prevent mother to child transmission) until its toxicity was determined (Weinel 2007).

Those who believed HIV was the cause of AIDS and supported the use of antiretrovirals did agree that the South African situation was different than that in the US, that local research and guidelines were needed, and that interventions such as provision of clean water and better sanitation were also necessary as a matter of increasing general health. However, they maintained that transmission occurred primarily through sex, contact with infected blood, or through childbirth and breastfeeding, and that this was where specific public health measures should concentrate, with distribution of AZT organised through the public hospital system. Despite concluding with a discussion of the importance of experiments to answer the causality question once and for all, the report as a whole leaned heavily towards the dissenters, who argued that experiments can 'never prove or disprove the HIV theory of AIDS' (p. 97).⁴

Because the panel expressed oppositional conclusions, the report was immediately criticised as confusing and unhelpful. Manto Tshabalala-Msimang, an obstetrician who had been appointed by

³ Rasnick was a collaborator on several key papers (Duesberg and Rasnick 1998; Duesberg et al. 2009). Bialy (2004) went on to write a laudatory biography of Duesberg. Mhlongo was another ANC member who obtained his medical degree while exiled in London in the 1960s. He had returned to South Africa in 1999.

⁴ Mhlongo went on record shortly thereafter reiterating his doubt that the HIV virus even exists (Shenton 2000), a position he continued to advocate until he died in a road accident in 2006.

Mbeki as Minister of Health,⁵ dismissed as 'elitist' the subsequent declaration signed by 5000 doctors affirming that HIV was indeed the cause of AIDS (Durban 2000), while the President's spokesman, Parks Mankahlana, called the declaration worthy only of 'a dustbin' (Dempster 2000).⁶ An international furore subsequently erupted over Mbeki's address to the 13th International AIDS Conference in Durban in July, in which he reiterated the argument that poverty, not HIV, was the main cause of death and illness in Africa (Mbeki 2000).

Stating that he was causing 'confusion', Mbeki withdrew from the debate on HIV, leaving Tshabalala-Msimang to process the panel report. This lack of direction from the administration meant that 40% of the AIDS budget from the year 2000 remained unspent (Sparks 2003: 265), leading to substantial pressure on the government and the ANC by civil society activists, health professionals and the international community. This culminated in the government's loss of a constitutional court lawsuit demanding the provision of drugs to prevent mother to child transmission of HIV (Cullinan and Thom 2009). In 2002 the government finally began instituting programmes for delivering antiretroviral drugs through public hospitals to pregnant women and in 2004, the Cabinet of Mbeki's government passed a resolution to make antiretroviral therapy available in public hospitals to patients with a CD4 cell count below 200 (indicating progression to full-blown AIDS). Implementation, however, was slow and despite the 2002 declaration that the 'government's starting point is based on the premise that HIV causes AIDS' (statement of Cabinet, quoted in Simelela and Venter 2014) was repeatedly obstructed by governmental red tape, so that the situation did not significantly change until the regime itself changed hands in 2009 (Motsoaledi 2013). Today, despite better policies that include provision of antiretroviral drugs, the economic and cultural change needed to make prevention initiatives more effective (such as medical infrastructure, better nutrition, and acceptance of the need to use condoms) is still lacking. South Africa still has the highest percentage of HIV-infected people in the world (AFSA 2016).

It has been claimed that approximately 330,000 people died between 2000 and 2005 because of the lack of adequate treatment (Chigwedere et al. 2008). Others have challenged that figure, including Mbeki himself, who has recently addressed the controversy in a series of Facebook postings discussing his legacy (Mbeki 2016). Seen as part of Mbeki's larger project for South African unity and economic development post-apartheid, it has been argued that his actions may have ultimately helped people in Africa living with HIV and AIDS by drawing international attention to the structural aspects that exacerbate ill health, such as endemic poverty, lack of resources for medical care, and the exceptionally high prices being charged for life-saving drugs (Sheckels 2004), which are now available in Africa at a fraction of the price charged in the West. However, poverty, stigma, denial and long waiting lists for treatment remain.

Wider lessons and insights

Mbeki's self-education programme illuminates specifically what can happen when a policymaker, reading primary source material, comes to consider him/herself an expert on a scientific matter, without perhaps understanding the full significance of the criteria used, and the way in which

⁵ Although initially supporting the use of another antiretroviral, nevirapine, to prevent mother-to-child transmission, Tshabalala-Msimang quickly fell in line with Mbeki's denialist views.

⁶ Mankahlana died soon after, of an undisclosed condition many claimed was AIDS (Dempster 2000).

science evolves over time and with the invention of better instruments (Weinel 2007). Having become persuaded by the arguments of scientists whose views were marginalised by the main AIDS community, but whose scientific credentials in an adjacent field were widely lauded, Mbeki was also able to use this work to claim a scientific basis for health policies which were more closely aligned with his stated overall objective of creating national cohesion and freeing South Africa from Western control by seeking local solutions for South African problems.⁷ Paradoxically, despite the Western origin of his own dissent, Mbeki continued to reject conflicting scientific advice about HIV from South Africa's top scientists, including those who were closely aligned with the ANC and with his other goals, as being influenced by established interests.

However, aspects of the dissenting arguments are not without merit, and had credibility amongst AIDS activists in the early years when the toxicity of AZT was greater due to higher dosage, and Burroughs Wellcome was generating enormous profit as its sole supplier despite the lack of evidence that it provided any clear benefit in the long term (see Crimp 2011, also Garfield 1993). The Maputo statement had also agreed that poverty, homelessness and poor health care were a contributing factor in the spread of HIV in Africa and condemned the apartheid government for 'sexism, victim-blaming, and racial stereotyping' in its handling of the crisis. Pharmaceutical company profits, undesirable side effects, inadequacy of public health care, and confluence with other diseases of extreme poverty have continued to inform discussions of AIDS in the developing world, regardless of the speaker's position on HIV or AZT. Therefore, while the weight of scientific evidence now clearly links HIV infection to AIDS, it is equally clear that there are also structural conditions that contribute to its higher mortality and morbidity in poorer nations.

The Mbeki case also highlights the political dimensions of science advice from both sides, particularly when there is a potential career cost for advisors who disagree with power and/or a mutually reinforcing benefit when – for different reasons – politics and science agree. An additional factor is the very complex science of etiology (determination of causality in disease), from which criteria known as 'Koch's postulates'⁸ (if virus X is the cause of disease Y, then X must be present in all Y patients, and all people with X must develop Y) have been called upon to disprove the claim that HIV is the cause of AIDS. However, other potential causal agents, which have failed the strict letter of Koch's postulates, are still widely accepted – most notably for poliovirus, which could not be isolated from every case, and hepatitis B, in which the indicator of exposure is also an antigen in the absence of an isolated virus (Harden 1992). It should also be noted that Koch himself was not able to fulfil his own postulates when he discovered the bacterium that causes tuberculosis. The claim that HIV is a harmless passenger virus which may be co-present but is not the cause of AIDS (Duesberg et al. 2009)⁹ cannot, therefore, be proven without identification of another definitive agent. However, there is little incentive and even less funding for such research.

⁷ Some of the treatments proposed for those diagnosed as HIV-positive, such as the herbal remedy *ubhejane*, may indeed have had some strengthening effects on the immune system which led users to feel objectively better, while others, such as virodene, a drug derived from an industrial solvent, most likely did more harm than good (Specter 2007).

⁸ Named after a founding father of nineteenth-century bacteriology, Robert Koch.

⁹ *Medical Hypotheses* was forced by its publisher, Elsevier, to withdraw the paper after complaints led to its being subjected to an external peer review, where it was rejected. The controversy also led to the removal of the journal's editor.

In offering to act as Mbeki's advisors, Duesberg and his fellow travellers were able to project their theory into the international arena outside the AIDS community, thus attempting to right what they saw as a great wrong, and where – particularly thanks to the internet – they have found enduring support.¹⁰ An equally difficult dilemma for science advice is that dissent is part of the process by which scientific paradigms change, and therefore it does play a legitimate function. For example, the other Nobel prize in Medicine for 2008 was given to Harald zur Hausen, who proved the role of human papilloma virus in cervical cancer, a claim that was also dismissed by the scientific consensus of his time. Therefore, while some of the dynamics at play were specific to the particular time, place and personalities involved, understanding the complex relationship between science and politics in this case may also shed light on other equally complex situations, such as climate change denialism, where politicians also point to the research of a small number of credentialed scientists as evidence that a largely-accepted causal effect is wrong, and therefore the recommended remedies need not be taken.

QUESTIONS FOR REFLECTION

- How should complexity and uncertainty be communicated without simplifying to the point that science becomes inaccurate, particularly when a dispute turns on nuances of methodology for validation not familiar to those outside the field?
- The designation of 'epidemic' was originally based on the presence of HIV antibodies, not full-blown AIDS, in a time when it was not known how long it might take people to become symptomatic. How can good advice be given when there is a lack of useful data upon which to base it?
- What is the best way to advise a policymaker who considers him/herself an expert on a scientific matter? How might the international and national aspirations of policymakers affect the choice of science advisor, as well as that advisor's capacity to give good advice?
- Two specific problems in South Africa were the legacy of apartheid, which left a situation of distrust of former elites (including international donor agencies), and cultural attitudes towards condoms which were important to people's sense of wholeness and identity but complicated prevention programmes. Should a science advisor take account of the social and political context of the questions s/he might be asked, and if so, how might that affect the giving of impartial advice?

¹⁰ See, for example, <http://virusmyth.org>, <http://rethinkingaids.com> and <http://aidswiki.net>.

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EDITORIAL NOTE

This case is developed by and for members of the INGSA network. Although efforts have been made to ensure that cases are as factual as possible, we welcome feedback and suggestions for revision.

PHOTO CREDITS

COVER - AIDS Prevention: Condom dispensers in toilets, Johannesburg SA. Source: Jorge Láscar via Wikimedia, CC-BY 2.0.



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INGSA CASE STUDIES

FUKUSHIMA - THE TRIPLE DISASTER AND ITS TRIPLE LESSONS:

*What can be learned about regulation, planning, and communication
in an unfolding emergency?*

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FUKUSHIMA DAIICHI NUCLEAR POWER PLANT, MARCH 2011

FUKUSHIMA - THE TRIPLE DISASTER AND ITS TRIPLE LESSONS

What can be learned about regulation, planning, and communication in an unfolding emergency?

On 11 March, 2011 a magnitude 9.0 earthquake struck off the North-eastern coast of the Japanese main island of Honshu. Although reactors at the Fukushima Daiichi Nuclear Power Plant shut down as expected, the 15m tsunami which followed caused a loss of power which disrupted the cooling systems. Over the next few days, four of the six reactors experienced catastrophic events, requiring the evacuation of plant personnel and residents of nearby villages in a 20km radius. Nuclear contamination has continued to hinder clean-up and reconstruction efforts in Fukushima prefecture, one of the three worst hit by the tsunami, and it is estimated that the plant itself could take up to 40 years to decommission. Moreover, subsequent investigations have revealed serious systemic issues in the regulation of nuclear power and in the mechanisms for provision of scientific advice to the public, policymakers, and to disaster response personnel, which has contributed to a considerable loss of public trust in both scientists and the Japanese government. Handling of the 'triple disaster', therefore, raises important questions for understanding the scale and extent of nuclear contamination after accidental release, but also about the need for realistic emergency planning and for consistency, accuracy and trust in the dissemination of useful information, not only during an unfolding disaster and immediate recovery period, but often for years, even decades, to come.

Background and context

A technologically advanced but geographically small country with a dense, rapidly-aging and shrinking population, in 2011 Japan had 54 nuclear power plants, which provided 29% of its electricity. The decision to rely on nuclear energy, taken in the 1950s as part of the Atoms for Peace Program, was partly predicated on Japan's geology, which has only very limited fossil fuel deposits that have never been successfully extracted for large scale use, and partly by the desire to pursue a fast path of technology-enabled, power-intensive economic growth (Drash 2011).

As Japan has experienced eight +8 magnitude earthquakes since 1900 (USGS 2012), the safety of the nuclear industry has been a key concern. Although the nuclear power plants did not come under threat during the 6.9 magnitude Kobe earthquake in 1995, some 5000 people died as buildings collapsed, and building codes were significantly strengthened as a result. A Brookings Institution report issued five days after the 2011 earthquake concluded that the early-warning system developed in Kobe's aftermath, which stopped trains and sent a local tsunami warning within three minutes of the quake hitting land, had functioned well (Kaufmann and Penciakova 2011). All 11 nuclear reactors in the area, including those at Fukushima Daiichi, had safely shut down at the first sign of earth movement, as they had been designed to do (World Nuclear Association 2014). However, the resulting tsunami overwhelmed existing seawalls and spread much further inland than expected, resulting in the vast majority of destruction and death (Kaufmann and Penciakova 2011). This flooding caused the backup generators for the reactors' cooling systems to fail.

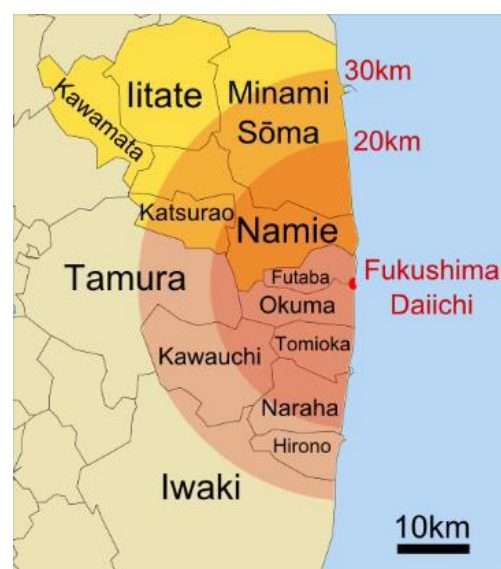
A number of factors complicated the response to the nuclear aspect of the triple disaster, from unprecedented complexity and inability to access the plant itself to ascertain the damage, to long-institutionalised practices within the nuclear industry, such as collusion between regulators, electric

power companies, scientists and even labour unions in keeping information about nuclear safety violations veiled from the public. In part this has been attributed to various factors such as the overly-close ties between groups and organisations producing lax reporting standards and confused lines of responsibility, and involving, for example, exchanges of key safety personnel between regulators and electric power companies (*shukko*), and retirees parachuting from regulatory bodies into executive posts in electric power companies (*amakudari*) (Matanle 2011). These relationships were close enough for the term '*genshiryoku mura*' (nuclear village) to be used to describe the workings of the nuclear industry. The report of the National Diet of Japan's Fukushima Nuclear Accident Independent Investigation Commission (formed by statutory law) admitted that the nuclear part of the triple disaster was 'profoundly manmade' (NAIIC 2012: 9) and recommended that the regulators, the operators and the laws governing the nuclear energy sector all be reformed. The government's own Investigation Committee further concluded that TEPCO had failed to prevent the disaster largely because it was considered too unlikely to be worth the required investment in time, effort or money (ICANPS 2012), despite evidence of earlier destructive tsunamis as recently as 1896 and 1933, and Fukushima's siting directly on the coast.

The dilemma

The Great East Japan (Tōhoku) Earthquake was a magnitude 9.0 undersea earthquake which took place at 14.46pm JST on Friday 11 March, 2011 approximately 70 miles east of Sendai, Honshu (the main island), Japan. The earthquake was the strongest ever recorded in Japan, and the fourth strongest world-wide since record-keeping began in 1900 (USGS 2012). Taking place along a 'subduction zone', where two tectonic plates have overlapped and built up enormous stress over time, the Pacific plate moved approximately 50 meters west, shifting the island of Honshu 2.4m east and tilting the Earth 10cm on its axis (Voigt 2011). However, the majority of the destruction and loss of life occurred during the tsunami which followed, which sent waves up to 33 feet and as far as 10km inland in Miyagi prefecture (COE-DHMA 2011), as well as across the entire Pacific region. Over 100 designated evacuation sites were engulfed by the tsunami (Kyodo 2011), and in the direct aftermath some 370,000 people were displaced.

The Government of Japan declared a State of Nuclear Emergency on Friday, 11 March, due to instability of the reactors at Fukushima Daiichi Nuclear Power Plant, operated by the Tokyo Electric Power Company (TEPCO). The plant is situated directly on the Eastern coast of Fukushima prefecture, 112 km south of Sendai and 270km north of Tokyo, and consists of six reactors, of which three had been online at the time of the earthquake. Although the reactors had all shut down during the earthquake as designed, the earthquake had cut off the power supply for the pumps which controlled the cooling systems for the reactors, and the back-up generators had flooded during the tsunami. As nuclear fuel requires cooling even when the plant is shut down, this was a major concern. A nuclear emergency was immediately declared and residents within a 30km radius were evacuated.



On Saturday, 12 March, the Japanese Nuclear and Industrial Safety Agency (NISA) reported that a hydrogen explosion at 7.30am had damaged the reactor building at Unit 1, but the primary containment vessel had not been breached. Sea water was being injected into the vessel to bring the core temperature down. Authorities extended the evacuation to towns within a 20km radius of the plants, and distributed units of stable iodine to evacuation centres 'as a precautionary measure' (COE-DHMA 2011). On the 13th, a controlled release of vapour into the outer container and sea water injection began at Unit 3 in an attempt to lower pressure and cool the reactor and Chief Cabinet Secretary Edano admitted that a partial meltdown might be underway. At 11am on Monday, 14 March, the IAEA reported a similar explosion at the Unit 3 reactor, followed by an explosion at Unit 2 at 9.14pm which sent a plume of smoke into the air and was deemed to have possibly breached the primary containment vessel. A fire at Unit 4 just before midnight appeared to self-extinguish after approximately two hours. The IAEA's 11 March offer of direct support and co-ordination was now accepted.

By the 17th of March, water levels in all the reactors had become a concern, although the situation was less critical for Units 5 and 6. There were also serious concerns about the integrity of the cores of Units 1, 2 and 3, and water levels and temperatures in the spent nuclear fuel pools at Units 3 and 4. An update on 19 March confirmed that at least some of the fuel in Units 1-3 was exposed, and that there was white smoke coming from Units 2-4. Units 5 and 6 were successfully placed into cold shutdown on 20 March. By mid-May it was determined that the fuel in Unit 1 had been completely uncovered and had probably melted to the bottom of the reactor pressure vessel very early in the accident. Units 2 and 3 also suffered at least partial meltdown of their cores.

In the following days high levels of Iodine-131 and Caesium-137 were detected on the ground at a number of locations close to the plant, in milk and some vegetables produced in the surrounding areas, and at points of the plant where effluent was being discharged into the sea. In April, the IAEA concluded that 'radioactive material from the damaged Fukushima Daiichi plant is gradually spreading outside Japan into the global atmosphere but at extremely low concentrations that do not present health or transportation safety hazards' (IAEA 2011). These levels spiked and then began to decline by the end of May, which was expected as most of the isotopes detected have a short half-life, however evidence of contamination continued to spread. An exclusion area remained, into which some evacuees were allowed in order to retrieve belongings after September. Ultimately, the accident was declared a level 7 on the International Nuclear Event Scale, matched only by Chernobyl, although most later estimates place the total release of radioactivity by the Fukushima disaster at approximately 10% of scale of Chernobyl.

As of March 2016, 15,894 deaths were confirmed with 2,561 people still missing, and close to 230,000 people were still displaced from the region (Japan Times 2016). Almost 130,000 buildings had been destroyed and another 1 million were either partially or significantly damaged. A report released by IAEA in August 2015 concluded that the nuclear disaster was caused in part by inadequate and poorly-implemented regulation, weaknesses in plant design and in emergency management, and a general assumption that Japan's nuclear plants were so safe that a major accident could never happen (IAEA 2015). Although some countries have rolled back their nuclear programmes since, in general civil nuclear programmes worldwide have continued under the assumption that the incident was exceptional and its results 'tolerable' as no one died immediately from exposure to radiation (Downer 2014: 3). Globally, the industry continues to give assurance that it has increased safety measures as a result. However, TEPCO has continued revising its radioactivity data for contaminated groundwater upward, and further events, such as Typhoon Etau, which overwhelmed the drainage systems in September 2015, have driven radioactive water stored at the plant into the sea (McCurry 2015).

At present, decommissioning is still in its early stages, aided by robotics as some of the reactor buildings are still too hot to enter. A sea-side impermeable frozen wall has been completed to stem seepage and a land-side wall is in progress, as well as extensive waterproof paving to mitigate continued contamination by groundwater from the site (METI 2016). In the aftermath of Fukushima, all of Japan's nuclear power plants were shut down for inspection, but so far only 26 have applied to resume operations. Four have returned to active duty but there is considerable pressure to speed up the pace in light of Japan's carbon reduction obligations (NEI 2016).

The role of scientific advice

One significant outcome of the Fukushima disaster was that public trust in scientific knowledge and government advice in Japan was seriously undermined (Grimes et al. 2014). Japan did not, at the time, have a Chief Scientific Advisor, and although the Nuclear Safety Commission and the Science Council of Japan both gave advice to the Cabinet, there were no formal mechanisms in place to channel independent scientific advice to the government or the public (Arimoto and Sato 2012). Within a febrile atmosphere and under rapidly changing conditions, the Japanese public therefore had to rely on media coverage of variable quality and accuracy for information unfiltered by the government or TEPCO. For example, television channels' frequent use of debate style programme formatting meant that the public was given widely diverging and conflicting interpretations by experts of the risks and dangers that the nuclear disaster posed.



The NAIIC (2012) report also points to a situation of distrust between TEPCO's on-site management, the regulatory agencies and the Prime Minister's office in the initial stages of the event, particularly after the latter journeyed to the site to give directions while TEPCO's CEO was in transit and could not be reached. The report suggests that it is likely TEPCO management initially attempted to downplay the seriousness of the event because they believed this was what the government wanted, in the interval when neither the Prime Minister's Nuclear Emergency Response Headquarters, the

Secretariat of the Nuclear Emergency Response Headquarters of NISA, nor the Regional Nuclear Emergency Response team were functioning as planned.

Scientific and technical advice was eventually sought from a number of international sources, including the International Atomic Energy Agency (IAEA), the US Department of Defence, and the World Health Organisation. The IAEA provided daily updates from 11 March until 2 June, tracking the progress of containment activities, based on information provided by Japanese sources, in particular TEPCO and the Nuclear and Industrial Safety Agency (NISA). However, both were deemed by the public to have vested interests in protecting the company, the industry, and the country (Shiroyama 2015), so that within Japan there was not much confidence in the information coming from these sources or from the government. Additionally, as the crisis unfolded, the radiation information released by IAEA became too technical for anyone apart from nuclear scientists to understand, and media coverage aimed at reassuring the public often included engineers who were unprepared for either the media attention or for the kinds of questions about radiation exposure being posed (Oppenheim and Franklin 2016).

In the very confusing aftermath of the explosions at Units 1-3, the UK embassy in Tokyo arranged for a conference call between UK nationals in Japan and Sir John Beddington, the British government's Chief Science Advisor and chair of the Cabinet Office's Scientific Advisory Group for Emergencies (SAGE), which is convened only in times of extreme emergency (see Beddington 2011; Grimes et al. 2014; Oppenheim and Franklin 2016). The call appears to have allayed the fears of many UK expats then in Japan, who were advised they were in no immediate danger of radioactive contamination as long as they remained well outside the evacuation area. Beddington himself was honoured by the Japanese Embassy in 2014 for his part in the effort to promote confidence in the Japanese Government's actions (Embassy of Japan 2014). While there were initially plans to create a similar system of Chief Scientific Advisors, with the election of a new government this seemed to have stalled (Arimoto and Sato 2014). So far, only one science advisor has been appointed, to the Minister of Foreign Affairs (MFAJ 2015).

One of the key continuing problems has been the gathering and dissemination of useful information in languages which are not Japanese, exacerbated by low international collaboration rates and a systemic difficulty in working across disciplines in Japan (Sugiyama et al. 2016). Much of what is available in English is written for nuclear scientists and is therefore indecipherable for policymakers or the general public, while questions about radiation in the exclusion zone only become more crucial as time passes, particularly for evacuees who wish to return. Science advice in this instance has often been a case of double translation, from the technical into the mundane as well as between Japanese and (predominantly) English. The IAEA's (2015) conclusion that levels are in general safe has been contested by Greenpeace (2015) and other organisations, leaving the question of when or whether evacuees will be able to return home largely unresolved. In the meantime, new technical problems have arisen as the decommissioning operation progresses, such as disposition of 1,000 tanks of irradiated water accumulated in the process of cooling the reactors (Mathiesen 2016).

In addition to physical damage, social and economic damage due to mass evacuation will continue to be complicated by Japan's overall trend of depopulation and migration away from rural areas, which had been affecting the Tōhoku region (Matanle 2011). Employment, in particular, has been an ongoing concern, as many jobs have now been permanently lost, and those created by reconstruction cannot be expected to last (Genda 2011). Disagreement amongst medical researchers makes it difficult to predict radiation-related longterm effects (see, for example, Aliyu, et al 2015), while mental and physical illness due to the ongoing stress of evacuation has also been observed (Rubin *et al.* 2012).

Fukushima, therefore, represents not only a need for advice from nuclear scientists and health professionals, but from social scientists as well.



This then begs the question of which advice to follow when experts disagree, and which types of knowledge to prioritise when academic experts diverge in their consideration of issues and problems to resolve. Governments worldwide have also often been accused of choosing to hear only the advice that serves ideologically conceived policy, ignoring that which contradicts their worldview, and academics who raise a dissenting voice may find promotion is denied - hence concerns about the ways that knowledge is interpreted and put to use (Downer 2014), and the potential for regulatory capture and marginalisation of nuclear critics (Kingston, 2014).

Wider lessons and insights

Since 2011, there have been three investigations of the incident, which have come to similar conclusions that there had been a culture in which industry representatives successfully lobbied regulators to promote their company's interests over those of the public, resulting in a downplaying of risk which ultimately compromised safety (Shiroyama 2015). Introducing new regulation may have been seen as a loss of face, an admission that nuclear power was not, in fact, as safe as the government and the industry claimed, and therefore lessons from prior earthquakes were not always put into practice (Thatcher et al. 2015). These investigations resulted in the separation of NISA from the Ministry of Economy, Trade and Industry, and the establishment of an independent Nuclear Regulatory Authority in September 2012.

The problem of industry lobbying, however, is not confined to Japan. An FOI request for emails exchanged between the British government and key players in the nuclear industry in the immediate aftermath of Fukushima suggested that there was great concern within the Department for Business,

Skills and Innovation (BIS) about the adverse effect on Britain's nuclear plans, and BIS was keen to develop a 'joint communications and engagement strategy' to reassure the British public that nuclear power was safe (Edwards 2011). While the 'myth of nuclear safety' may have been stronger in Japan, it is not non-existent in other countries, particularly those which have invested in the 'nuclear renaissance' (World Nuclear Association 2015; Johnson 2015). While Germany decided to phase out nuclear power in the wake of Fukushima, and Spain and Switzerland have banned new construction, some countries – including the UK and the US – have reinvigorated their programmes, citing superior safety regulation, new technology, and the need to transition away from fossil fuels (Johnson 2015). These key lessons from Fukushima, namely a need for robust and independent regulation, clear protocols in the event of an accident, and experts trained in communicating complex and uncertain science to the public, will therefore continue to be of vital importance, particularly in countries pursuing civil nuclear power for the first time.

Finally, there is the question of whether it would be useful to develop formal institutional mechanisms for gathering, analysing and filtering scientific knowledge into advice for governments and other actors to put into practice. Potential models exist in the form of the UN's Inter-Governmental Panel on Climate Change (IPCC), or the UK's Scientific Advisory Group for Emergencies (SAGE). Five years after the Fukushima crisis exposed the fragility of the role of scientific advice in Japan, the country still grapples with the question of how to put an effective system in place.

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QUESTIONS FOR REFLECTION

- Incidents at the plant were unfolding very quickly in the first days. How soon should scientific advisors become involved and with whom? Should their expertise be directed solely at decision makers, or do they have a significant role to play with regard to clarifying an unfolding situation for the media and the public?
- How might the international nature of the issue affect the role of the Chief Scientific advisor in this case? To what extent might preserving the sovereignty or reputation of the country influence the ability to speak freely and to whom?
- Public trust in risky technology is often predicated on trust in regulatory bodies for setting adequate levels for safety and enforcing regulation in the public interest. Regulators, however, are also tasked with ensuring that the industry can function economically. To what extent can scientific advice help with the setting of reasonable regulatory goals?
- What kind of science advice will continue be required as evacuated residents return home? How should 'safe' levels of radiation exposure be communicated and what kind(s) of support systems should be in place for continued monitoring of the health of residents and workers, without causing undue concern?
- What mechanisms are required for accurate scientific knowledge and advice to be channelled to governments and the public prior to and during emergencies? How should these mechanisms be structured? And what are the potential difficulties involved in developing these systems?

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PHOTO CREDITS

COVER: Reactor Units 3 and 4 at Fukushima Dai-ichi after Tōhoku earthquake and tsunami, 16 March 2011. Credit: Digital Globe, CC BY-SA 3.0. Source: <http://www.flickr.com/photos/digitalglobe-imagery/5530841229/in/>

PAGE 3: Japan towns, villages, and cities in and around the Daiichi nuclear plant exclusion zone. Credit: Mayhew, derived from Lincun -CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=15005400>

PAGES 5 and 7: Shore area, Ishinomaki City, August 2011. Credit: Peter Matanle, CC BY-NC-SA.



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INGSA CASE STUDIES

“ROUNDUP READY”? REGULATING GLYPHOSATES AMIDST HEALTH, ECONOMIC AND PUBLIC CONCERNS ABOUT GM

Tatjana Buklijas (INGSA Auckland)
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CHAFER SENTRY APPLYING GLYPHOSATE TO STUBBLES IN NORTH YORKSHIRE ON A SUNNY DECEMBER DAY

“ROUNDUP READY”? REGULATING GLYPHOSATES AMIDST HEALTH, ECONOMIC AND PUBLIC CONCERNS ABOUT GM

Glyphosate is a leading herbicide, most notably sold as the compound Roundup, which is used in conjunction with crops genetically engineered to be resistant to its effects to reduce pesticide use and increase yields. However, Roundup is also used in maintenance of public parks, pest control in forests, and is sold in gardening centres for household use. Glyphosate itself is used in hundreds of products, making it difficult to fully test in combination with other chemicals which might be used. In light of this, its exact toxicity to humans, bees and the environment in general has been difficult to determine, and has formed a significant area of public resistance to genetically modified organisms. Recently, the licence for glyphosate has come up for renewal in the European Union, opening up the debate about a blanket ban once again. This debate has been recently complicated by the WHO's reclassification of glyphosate as a probable carcinogen, a conclusion that was subsequently challenged by the renewal process, during which the report on acceptable risk issued by EFSA concluded that glyphosate was in fact not carcinogenic if used according to the limits set.

Background and context

In 1974, the multinational biotechnology corporation Monsanto launched a new broad-spectrum herbicide based on the active substance glyphosate.¹ Marketed under the trade name 'Roundup', this herbicide was part of the corporation's large scale involvement in the “green revolution”, a global project supported by the World Bank that aimed to increase food production in developing countries through the industrialization of agriculture and extensive use of fertilizers and pesticides. At its introduction Roundup could help clear land for cultivation, but it could not be used on arable crops because crop species as well as weeds succumbed (Duke and Powles 2008).

In the early 1980s Monsanto scientists began working on genetically modified plants which would be engineered for resistance to Roundup, thus allowing use of the compound to remove invasive weed species without damaging the crops. This was done using genetic modification to insert a bacterial gene which produced an enzyme to bypass the toxic effects of glyphosate. In 1994 the corporation released the first transgenic glyphosate-resistant crops—soybeans and canola, followed rapidly by cotton, maize and sugar beets (Cerdeira & Duke 2006). The uptake of these transgenic crops was spectacularly fast and wide, first in North and South America but also globally (James 2015). Monsanto claimed this combination of herbicide and GM seed modified to resist the herbicide enabled food producers to reduce the use of other weed-control tools (chemical or mechanical). Furthermore, glyphosate was claimed to be relatively harmless because it bound tightly to soil constituents with little movement through either soil or groundwater, and had a short environmental half-life with no atmospheric contamination because it is not volatile.

¹ (N-(phosphonomethyl)glycine)

Initially, the WHO classified glyphosate as “probably not carcinogenic to humans”. Multiple studies found it was not retained in animal tissue, while reports of potential toxicity in humans were generally blamed on surfactants (chemical additives to the Roundup compound), not on the glyphosate molecule itself, which was deemed non-carcinogenic and not developmentally toxic (Williams *et al.* 2000). However, many of the studies reviewed at that time were carried out by Monsanto, and the structure of risk evaluation studies could leave questions about longer-term exposure unanswered.

A highly controversial paper was published in 2012 by a French scientist, Gilles-Éric Séralini, who had a history of publishing anti-GM claims. To immense and controversial publicity by the author at the time of its release, the paper suggested that Roundup did indeed cause tumours in rats when studied over a longer period. This paper was withdrawn by the publisher a year later after vigorous criticism of its statistical and scientific validity by the scientific community (including several French Académies). It was eventually republished without any further peer review in a different journal along with the raw data (Séralini *et al.* 2014).

As time went on, it was noted that resistance to glyphosate was beginning to increase in both GM crops (Gilbert 2013) and in related weeds through exchange of genetic material, causing farmers to apply other herbicides along with glyphosate-derived products and thus increasing rather than lowering the total volume of herbicide use (Cerdeira & Duke 2006).² Resistance is also driving development of new herbicidal formulations that carry multiple active ingredients (Freedonia 2012 in IARC 2012), which may bring new risks to the environment and animal/human health.

Monsanto now controls 26% of the global seed market (Jones 2015), while 89% of corn and 94% of soybeans grown in the US are from patented GM seeds (USDA 2016). These increasingly include ‘stacked’ traits (i.e. resistance to insects as well as herbicides), particularly in corn and cotton. Monsanto’s market dominance is presented by activists as an exemplar of an agro-industrial business model which is pushing smallhold farmers into debt for the purpose of increasing profit (Zacune 2012).

The dilemma

Although there has been widespread uptake of GM crops by farmers in the USA and South America, this has been countered by widespread public resistance in Europe and other regions. In 2015, the EU voted to allow countries to block GM and to date 19 of the 28 member states have enacted bans, including of Monsanto’s bt maize, which at present is grown only in very small amounts in Portugal and Spain.³

² A report by respected consultants PG Economics concludes that pesticide use has in fact decreased by 8.2% due to adoption of GM (Brookes & Barfoot 2016). However, this company has also been flagged by Lobbywatch.org for having undeclared interests, and its research is often funded by industry lobby groups which include Bayer, Dow, DuPont, Monsanto and Syngenta (see <http://www.lobbywatch.org/profile1.asp?PrId=308>).

³ However, many EU countries which ban cultivation do allow import of GM products.

At the same time, the active ingredient in Roundup, glyphosate, was coming to the end of its approved licensing period in Europe, having been authorised in 2002. While Roundup accounts for a significant share of the agro-industrial market, including use by home gardeners, glyphosate is also used in a number of other products - more than 750 in the US alone (IARC 2012). It is therefore impossible to test each and every compound, particularly as new products continue to enter the market.

In Europe glyphosate must first be approved at EU level before member states can authorise its use in products for their own markets, and expiry of the approval would require all member states to withdraw authorisation for the sale of products containing it.⁴ Periodic renewal of this approval is required, and in this instance began in 2012. Although any person can submit information during preparation of the draft assessment report which is prepared by the Rapporteur Member State (in this case, Germany), EFSA is expected to make an active assessment only of the *technical* evidence it receives.

The role of scientific advice

In March 2015, the International Agency for Research on Cancer (IARC), the cancer-research arm of the WHO,⁵ released a report that assessed the carcinogenicity of five major herbicides, including glyphosate (Guyton, Loomis et al. 2015). The commission used evidence from human, animal, and mechanistic studies, i.e. those seeking to explain causative processes. The IARC concluded that there was “limited evidence” from human epidemiological studies to suggest a positive association between exposure to glyphosate and increased risk of non-Hodgkin lymphoma (NHL), as well as increased risk of childhood cancers associated with application of the herbicide by their parents, but other factors could not be confidently ruled out. Indeed, a large cohort Agricultural Health Study that follows thousands of agricultural workers found no significant increase of NHL. Animal studies (in mice) showed an increase in the incidence of a rare kidney cancer, and of connective tissue as well as skin cancer. “Mechanistic evidence” referred to the increase of blood markers of chromosomal damage in people after spraying of glyphosate, and evidence of glyphosate, glyphosate-formulations and oxidative stress induced by AMPA, a glyphosate metabolite in rodent and in vitro studies. While accepting that other factors could not be completely ruled out in the association with NHL, the report did conclude that there was sufficient evidence of carcinogenicity from experimental animals and from human *in vitro* mechanistic data to warrant reclassifying glyphosate from possibly to “probably carcinogenic to humans (category 2A⁶)” (IARC 2012). This is because the IARC used a hazard-based approach rather than a risk based approach – the former considers the potential of a substance to induce cancer independent of considerations of exposure and dose (Gluckman 2016).

⁴ See European Commission—Fact Sheet. FAQs Glyphosate. Brussels, 29 June 2016. http://europa.eu/rapid/press-release_MEMO-16-2012_en.htm

⁵ From <http://www.iarc.fr/en/about>: ‘The main objective of the IARC is to promote international collaboration in cancer research...[and] identify the causes of cancer so that preventive measures may be adopted ... The IARC Monographs Programme is a core element of the Agency’s portfolio of activities, with international expert working groups evaluating the evidence of the carcinogenicity of specific exposures.’

⁶ A category that also includes eating red meat, shift work, ingested nitrates and nitrites and many chemicals.

The IARC report provoked strong response. The agricultural industry and the farming sector were highly critical (Cressey 2015), with Monsanto accusing the IARC of bias (Levitt 2015). But a number of other stakeholders—environmental groups, opponents of GM crops, anti-globalization advocates—used the IARC report in new campaigns to mobilize public opinion, particularly in the European Union where there has been longstanding hostility towards GMO. In the face of rising media attention, with retail outlets removing Roundup and similar products entirely (Levitt 2015), the European Commission pushed for faster completion of the regular regulatory review of glyphosate that it had begun in 2012.

In November 2015, the relevant regulator, the European Food Safety Authority (EFSA), released a report that - in contrast to the IARC report - concluded that glyphosate was 'unlikely to be carcinogenic'. However, EFSA used a risk based approach, taking into account likely exposure, rather than general potential for harm. Thus it set for the first time safety thresholds for exposure, at 0.5mg per kg of body weight for consumers and 0.1 mg/kg for agricultural operators (EFSA 2015). The US Environmental Protection Agency has also recently concluded that glyphosate is not carcinogenic (EPA 2016).

The differences in the two reports can partly be explained by the hazard versus risk approaches of the two different agencies.⁷ While the IARC determines whether there is sufficient evidence to link a particular substance to a higher incidence of cancer, EFSA's brief is to determine the definition and criteria for "acceptable risk", rather than seeking definitive proof of absolute safety.⁸ In other words, the underlying questions and classification schemes are different, as are the statistical methods for for determining toxicity, and the substances investigated (EFSA's mandate is for glyphosate alone, whereas IARC also considered its use as part of a compound). Additionally, while the IARC report was based only upon publicly available reports, EFSA had access to a much wider range of studies, including proprietary studies carried out by industry, and a different system for weighting the conclusions. Thus, while the available data for human carcinogenicity was 'limited', the IARC assessed the **likelihood** that the chemical **might cause cancer** in humans to be of sufficient concern, while EFSA studies "whether there is sufficient **confidence** that a pesticide, when used according to the conditions of its approval (i.e. exposure patterns), **will not pose an unacceptable risk** to human health or the environment" (EFSA 2015).

Following release of the EFSA report, a group of 96 leading scientists sent a letter to the European Commissioner for Health and Food Safety, objecting to the EFSA decision on the grounds that the IARC had assessed evidence that was in the public domain and available to independent scientists to review, while the renewal assessment report provided to EFSA by the German Federal Institute for Risk Assessment (BfR) was partially based upon confidential studies conducted by industry groups which were not available to IARC to review. EFSA was also accused of using inappropriate criteria to dismiss positively correlative data. The letter further argued that while IARC had carefully evaluated the strength and weakness of each study assessed, weighted findings according to quality of the data, and clearly identified all studies considered, the BfR study provided no justification for their findings, all citations having been redacted from their report. Moreover, the determination of "no

⁷ <https://ec.europa.eu/research/sam/index.cfm?pg=glyphosate>

⁸ The sheer number of products on the market using glyphosate is beyond the capacity of any single agency to test, particularly as compounds such as Roundup can also include toxic additives, such as the surfactant POEA, or produce unexpected effects due to interactions between chemicals.

unequivocal evidence” was misleading, as IARC’s determination of “sufficient evidence” in the animal and mechanical data indicates that a causal relationship *has* been definitively established.⁹ The letter concluded that EFSA’s evaluation did not, therefore, “reflect the available science” and should be disregarded (Portier et al 2015).

Although EFSA did not categorize glyphosate as a possible or probable carcinogen, it still recommended restricting its use. Sweden, France and the Netherlands requested that the licence not be renewed. Several meetings of the EU member states failed to reach a qualified majority to either renew or refuse approval by the deadline of 30th of June, and the EU commission instead extended the current license for a further 18 months to allow another EU agency, the European Chemicals Agency (ECHA), to complete its own review (Stokstad 2016). It also recommended a ban on the surfactant polyethoxylated tallow amine (POEA) from glyphosate-based formulations; minimizing the use of glyphosate in public parks, public playgrounds and gardens; and minimizing pre-harvest use.¹⁰ Although none of these recommendations were binding, POEA – the ingredient in Roundup about which the IARC report showed most concern – was banned in early July 2016 (Michalopoulos 2016).

The issue remains ongoing: in the absence of clear consensus on the carcinogenicity of glyphosate to humans and with regard to the important role of glyphosate in the current model of food production, the potential impact of either continuing or discontinuing the use of glyphosate is profound. Additionally, reaction to the IARC report has reinforced the difficulty of separating what is an otherwise common herbicide from the seemingly intractable debates about the dangers of GM, and resistance to Monsanto itself as the symbol of industrialised agriculture. The differing conclusions of the two reports also suggests the complexities of risk assessment.

Wider lessons and insights

This case highlights a number of issues in the interaction between policy, regulatory agencies, the private sector and the public: issues where a science advisory mechanism has an important but complex role.

In the absence of clear consensus on the carcinogenicity of glyphosate to humans and with regard to the important role of glyphosate in the current model of food production, the potential impact of either continuing or discontinuing the use of glyphosate is profound. Additionally, reaction to the IARC report has reinforced the difficulty of separating what is an otherwise common herbicide from the seemingly intractable debates about the dangers of GM, and resistance to Monsanto itself as the symbol of industrialised agriculture. The differing conclusions of the two reports suggested that glyphosate must be assessed from multiple viewpoints.

First, there is the broader biological and environmental impact. Other than direct toxicity to humans and animals, glyphosate may have impact by reducing resources for certain organisms. For instance, glyphosate toxicity to milkweed may be the reason for the 80% drop in the population of monarch

⁹ The letter points out that in terms of public health evaluations, ‘limited evidence’ in the human data does not mean that the risk is negligible, but rather that causality is, while not unequivocal, credible enough to warrant concern.

¹⁰ http://europa.eu/rapid/press-release_MEMO-16-2012_en.htm

butterflies in North America in the last two decades—starting, strikingly, at the time of the introduction of glyphosate-resistant crops (Semmens, Semmens et al. 2016). The rise of ‘superweeds’ resistant to glyphosate (among other herbicides) dates from the introduction of GM crops in 1995 and there are now 23 resistant species in 18 countries (Heap 2014), the rise of which has been partly driven by Monsanto’s insistence as late as 2004 that continued use of Roundup on GM crops year after year would *not* produce resistance (Gilbert 2013). Both suggest an overall reluctance on the part of industry to accept scientific findings that require a change to corporate practice or to the chemical composition of the pesticides used.

Alternatives to glyphosate-based herbicides in general may be more productive for non-agricultural uses, for example in home gardens, and in parks and playgrounds. Some European countries have already limited the use of glyphosate for home use, leaving commercial applications intact. Weeds in home gardens and small green areas may be better managed by hand weeding and hoeing. Using “traditional” methods such as crop rotations, cover crops, crop management (crop competition, nutrition etc.) in commercial crop production would be more difficult as this could incur considerable cost, but has been recommended as a way of avoiding resistance even when planting GM crops.

The controversy has also shown the strength of the association of glyphosate with Monsanto and its problematic history as a supplier of the defoliant “Agent Orange” to the U.S. Army during the Vietnam War, which was later shown to have catastrophic consequences on the environment and human and animal health. Although Monsanto has attempted to separate its chemical and agricultural interests in recent years, and now proclaims itself a saviour of the honey-bee,¹¹ other practices – such as its lobbying of the US government to insert a clause called the Farmer Assurance Provision, which aimed to prevent judicial review of any genetically engineered crops,¹² into a short-term spending bill in 2013, have tended to cast a shadow over the entire sector in the public eye, particularly in Europe.

The case also points out the need for transparency in regulatory organisations, particularly the need to avoid the appearance of conflict of interest through use of confidential industrial reports. As most of the controversy around GM is values-based, and public confidence in regulatory agencies in general is low, any scientific advice given requires the utmost transparency in order to avoid provoking yet further conflict.

The authors would like to thank Anne Bardsley and Sir Peter Gluckman for their insightful comments on an earlier draft.

¹¹ <http://www.monsanto.com/improvingagriculture/pages/honey-bee-health.aspx>.

¹² The provision, which became popularly known as the ‘Monsanto Protection Act’, was dropped when the bill expired.

QUESTIONS FOR REFLECTION

- Much of the controversy over GM is values-based, in particular critiques over seed patenting, industrial agriculture in general and the practices of some corporations in particular. How can good scientific advice be given in that context?
- Policymakers and the public may have different needs, and different levels of understanding about the function of regulatory agencies. Given that the EFSA report relies upon confidential information and does not cite the source of the studies it evaluated to come to its conclusion, how can regulatory science be best explained to the public in particular, who may be much less inclined than policymakers to accept even minimal risk?
- Much has been made of the conflicting conclusions between the IARC and EFSA reports, yet scientifically they are not measuring the same thing. How can a science advisor help make clear the differences between determining causal relationships and determining safe exposure to potentially toxic chemicals?

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PHOTO CREDITS

COVER: Chafer Sentry applying glyphosate to stubbles in North Yorkshire on a sunny December day. Credit: Chafer Machinery, CC-BY 2.0 . Source: <https://www.flickr.com/photos/chafermachinery/15415567073>



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INGSA CASE STUDIES

THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE:

Transferable Model or Cautionary Tale?

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IPCC CLIMATE CHANGE REPORT GET'S EUROPEAN LAUNCH, 2012

THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Transferable Model or Cautionary Tale?

The Intergovernmental Panel on Climate Change (IPCC) is widely regarded as a successful example of global science advice. Its voluminous assessment reports are produced by thousands of volunteer scientists approximately every six years, who work across three Working Groups dealing respectively with the physical science, climate change impacts and adaptation, and mitigation options. Outlines of the reports, and the final content, are approved by government representatives, and are intended to form the main scientific basis for governmental policy-making. The IPCC has pioneered new ways of assessing scientific knowledge across a broad range of disciplines and interconnected topics, and has helped to cement climate change within international policy agendas. This success prompted the establishment of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) in 2012 (Beck et al., 2014) and calls for similar bodies to provide advice for other global policy challenges such as antimicrobial resistance (Woolhouse & Farrar, 2014). Observers from other grand policy challenges may cast an envious eye at the IPCC's undoubted symbolic power (Hughes, 2015). Yet attempts to transfer this model of knowledge production to other issues can be problematic, without detailed analysis of the IPCC's role in both climate science and politics. This case study provides an introductory overview of the IPCC's history and influence and the potential for 'the IPCC model' to be transferred into other policy issues.

Background and context

The IPCC was formed in 1988 under the World Meteorological Organisation (WMO) and the United Nations Environment Program (UNEP). Strong consensus statements had emerged from scientific conferences on climate change in the mid-1980s, but it was perceived by many that the political complexity of climate change was such that more was needed to drive political action. In light of dissatisfaction with the Advisory Group on Greenhouse Gases, a small, underfunded advisory group set up in 1986 by WMO, UNEP and the International Council of Scientific Unions (ICSU) which was arguably too distant from the policy process to be effective, calls were made for a more comprehensive international assessment effort (Agrawala, 1998). Following complex negotiations between the US Government and WMO's Executive Council, the road was paved for the emergence of the IPCC.

The emergence of the IPCC coincided with, and reinforced, a reconceptualization of 'climate' as a complex, global system. This was the outcome of decades of scientific work on the general circulation of the atmosphere, on the data and modelling infrastructures required to study it (Edwards, 2010), and the emergence of new ideas about how environmental problems could or should be managed through cooperation at the global scale (Miller, 2004). It was the novelty of the latter which arguably drove the desire for an *intergovernmental* institution, with various competing actors, not least across different departments of the US Government, keen to ensure governmental oversight of such consequential knowledge-making (see Agrawala 1998).

The focus initially was to be on providing a comprehensive assessment of climate change and its potential impacts, while debating the relative merits of possible response strategies. A number of developing countries expressed unease at this positioning of the IPCC across the science-policy

interface, fearing that the Western dominance of climate science would therefore enable them to dictate the terms of global climate policy, and in 1990 the Intergovernmental Negotiating Committee was formed as a separate setting for the drafting of what would become the UN Framework Convention on Climate Change (UNFCCC). Post-1990, the IPCC reverted more to scientific assessment, promising policy neutrality across its three Working Groups (WGs) dealing with the physical science (WGI), social and ecological impacts and adaptation (WGII), and mitigation options (WGIII). Each WG produces its own report, before working together to produce a more succinct Synthesis Report. Five Assessment Reports have been completed to date, in 1990, 1995, 2001, 2007 and 2014. In 2015, the IPCC decided to begin preparations for a sixth assessment report. These assessments inform parties to the UNFCCC and underpin UN negotiations.¹

The task of the IPCC is wide-ranging; to assess all the available science, and come to consensus statements about the present state and the future of anthropogenic climate change. However, it has addressed direct policy questions, such as the potential meanings of ‘dangerous’ climate change, which the UNFCCC is designed to avoid, and has provided focused assessments of topical questions like extreme weather (IPCC, 2012), renewable energy (IPCC, 2011) and the impacts of 1.5°C of warming in Special Reports (IPCC, 2016). The IPCC’s role in setting the scientific and political agenda on climate change saw it awarded the 2007 Nobel Peace Prize, alongside political campaigner and film-maker Al Gore.

The dilemma

The ‘headline’ findings of the five assessment reports have concerned global mean temperature rises to date and in future, and the ability of scientists to attribute these rises to human activities. This may seem natural to us now, but it wasn’t to many in the 1980s. Chris Russill (2016) has argued that this period saw a struggle to ‘frame’ climate change as either a question of global trend detection and management, or as a question of local climate-society interactions and risk management. Trend detection won out, due in part to the new dominance of global models, but also, Russill suggests, to contemporary US energy politics where the management of global trends was a dominant mode of thought and practice across science and politics. However, in the subsequent evolution of the IPCC over the next two decades, we can trace a shift in framings from climate change as a problem of additional carbon dioxide and temperature, to a problem of risk management. In recent WGII reports in particular, some of the concerns of the dissenting 1980s scientists, who lobbied for risk management rather than trend detection/management approaches, are starting to be addressed.

Implicit in the framing of climate change as a problem of global trend management is the assumption that climate change is a well-structured technical problem, within which scientific advice could act as a trigger for multilateral international agreement on ameliorative policy actions (Hoppe, Wesselink, & Cairns, 2013). However, many social scientists have argued that climate change is actually an unstructured, or ‘wicked’ problem at the global level, spanning both social and climate systems and containing deep cultural and political differences over values, goals and meanings (Demeritt, 2001; Hoppe et al., 2013; Prins et al., 2010). Framing climate change as a global problem with global solutions has been a natural progression of trends in both science and politics, but the result can be a heavily

¹ More direct scientific and technical advice, for example on the preparation of emissions inventories, is provided by the UNFCCC’s Subsidiary Body of Scientific and Technical Advice.

centralised supply of scientific advice that neglects the need for geographically differentiated and plural policy approaches (Hoppe et al., 2013)

Different framings of a problem have powerful effects on how solutions to the problem are conceptualised. Some have worried that the emphasis on global trend detection in IPCC reports has taken political and public attention away from the IPCC's treatment of adaptation questions, or pushed adaptation to the end of a chain of accumulating impacts where it functions as the social cost of failed mitigation (Beck, 2010; Hulme, 2011). It has been argued that we should be thinking more concertedly about adaptation to climatic extremes already evident, and less about determining their direct cause. Certain framings may also play better in different political cultures – trend and/or risk management may appeal to certain North American modes of thinking about environmental problems, which often place the burden of proof on proponents of regulatory action, but may not sit so well with more precautionary attitudes in Continental Europe, for example (Mahony, 2015). The IPCC has also faced controversy in the way it has framed issues concerning the global South – whether in the presentation of Southern forests as 'empty' spaces standing ready to suck up the carbon pollution of the global North (Fogel, 2005), or in the valuing of Southern lives at lower levels than Northern lives (Masood, 1995). These controversies point to the fact that in the context of an issue like climate change, scientific claims may not be simply 'neutral'. Rather, they shape the contours of how we think – politically, ethically, culturally – about responding to the issue at hand. Institutions like the IPCC exert great political and symbolic power (Hughes, 2015), and therefore face dilemmas about how to frame scientific issues in ways which are credible, legitimate and salient to a wide range of audiences.

Part of the IPCC's response to this dilemma has been a broadening of the disciplinary make-up and forms of knowledge which go into its assessments. However, repeated criticisms have been made of the under-representation of social science and humanities disciplines (with the exception of economics, which is well represented), despite their capacity to provide vital knowledge about the key drivers and potential victims of climate change – human beings and their societies (Bjurström & Polk, 2011). The IPCC has also been dominated by scientists from the global North (Ho-Lem, Zerriffi, & Kandlikar, 2011), leading to worries of bias towards problems and framings which are of greatest concern to Northern scientists and politicians (Orlove, Lazrus, Hovelsrud, & Giannini, 2014). In the case of a country like India, low participation of both scientific and political actors has been attributed to both a lack of interest in the science (as opposed to the politics) of climate change, and a widespread distrust of the IPCC as a potential vehicle of western diplomatic power (Biermann, 2001; Lahsen, 2007). Indeed, it was for this reason that India was among those calling for the IPCC's pre-1990 policy negotiation functioned to be removed (Miller, 2009).

The IPCC's acknowledgement of the social complexities of climate change impacts has grown over time, even if concepts like inequality or justice are yet to become key organising concerns. Debates have ranged over how to bring in the knowledges and experiences of people on the 'frontline' of climate change, for instance in the Arctic. This might mean revision on how expert authors are selected and included (Ford et al., 2016), or on how different types of knowledge are rendered credible and thus proper for inclusion. The public controversy in 2010 over a published mistake about when Himalayan glaciers may melt away brought to the fore questions about the inclusion of so-called 'grey literature' in assessments – literature which may not have been through the vetting procedures of scientific peer review, but which may nonetheless feature important insights from places where accredited scientists may have yet to tread. The tightening of grey literature guidelines to avoid embarrassing mistakes may therefore risk excluding certain forms of knowledge – and thus people and places – from the assessment process.

The role of scientific advice

The IPCC has, since its first assessment report, sought to deliver to policymakers a consensus statement on the state of the science of climate change. Consensus has thus become the hallmark of the IPCC process, achieved through the processes of collective authorship among large groups of scientists, a lengthy expert and government review process, and in lively plenary sessions where government representatives offer their approval (or disapproval) of the headline findings. To many commentators this presentation of a unified scientific voice on a global public stage has been central to the IPCC's authority to set the terms of debate (Pearce, Brown, Nerlich, & Koteyko, 2015). There is a symbolic power to the IPCC's self-positioning as the voice of a singular scientific community, labouring for many years to offer universal truths unto the altar of politics, where they may either be lauded as sacrosanct, or sacrificed to the higher gods of political ideology and material interest. However, some have argued that despite the symbolic and political power of scientific consensus, it may tarnish the process of producing objective assessments. A famous case concerned the production of estimates of end-of-century sea level rise in the 2007 report, wherein new model results suggested much higher rates of change than previous assessments. However, the unreliability of these results, owing to their comparatively new underlying methodology, meant that consensus could not be reached on them, and they were excluded from the headline statements which were much more conservative (O'Reilly, Oreskes, & Oppenheimer, 2012). Did consensus science serve the best interests of policy makers here? Perhaps the latter would be best served by being informed of not only what everyone can agree on, but of the probabilities – however low, or controversial – of high-magnitude future events, like rapid sea level rise, carrying great implications for things like the planning of coastal cities (Hansen, 2007; Oppenheimer, O'Neill, Webster, & Agrawala, 2007).

Consensus also raises important questions about how best to represent uncertainty. There are many forms and sources of uncertainty – incomplete understandings, observational and model error, expert disagreement, and so on – which are hard to communicate in a single language. The IPCC developed a set of likelihood and confidence statements which have slowly worked their way across the Working Groups, but these have been shown to be incompletely understood, particularly by non-scientific audiences (Barkemeyer, Dessai, Monge-Sanz, Renzi, & Napolitano, 2016; Budescu, Por, Broomell, & Smithson, 2014).

The challenges of consensus and communication also relate to the points above about problem framing, and the frequent inseparability of the epistemic and the normative in climate change science. The IPCC's attempts to produce state of the art, 'policy-neutral' scientific observations of the world are perhaps commonsensical, but they sometimes mean overlooking the societal values and processes that lie underneath the processes the IPCC seeks to describe. Put crudely, the scientific description of 'what is' can often be divorced from the societal 'what ought to be', at the risk of making the issue too distant from the everyday concerns of global publics, and thus undermining the capacities of those publics to make concerted, democratic claims for strong policy action (Jasanoff, 2010).

One example of the inevitable intermingling of facts and values is the recent controversy over so-called 'negative emissions' technologies in IPCC scenarios. These technologies, at this point essentially non-existent, were crucial in generating scenarios in which the world stayed below the commonly agreed upon threshold of dangerous climate change. However, questions of the social and political feasibility of these technologies, which would involve giving huge swathes of land over to bioenergy production, were side-stepped by the IPCC and science advisors, and the centrality of these technologies to the scenarios underplayed (see Geden, 2015). There are important questions here about how scientists should negotiate the links between questions of technical and social feasibility

of new technologies, for example, but also about how transparent they should be about the assumptions and values underpinning descriptions of the world as it is, and predictions of the world as it could – or ought – to be. For many, closer forms of knowledge ‘co-production’ (or collaboration between knowledge makers and users in assessment processes) is key to tackling these complexities, especially as bodies like the IPCC seek to move to more ‘solution-oriented’ approaches (see Tollefson, 2015). However, co-production can also challenge conventional means of establishing scientific and political authority and for a body like the IPCC, which values its status as the global scientific authority on climate change, more knowledge co-production could seem like an erosion of its autonomy – even though its autonomy is, by design, already incomplete as an intergovernmental organisation (Hoppe et al., 2013).

Wider lessons and insights

The IPCC is an extraordinary institution – perhaps the largest exercise in scientific cooperation ever embarked upon, and the producer of knowledge claims which have no doubt underpinned the steady push for global policy action. It is therefore not surprising that actors in other domains seek to emulate the IPCC model, for example Woolhouse and Farrar (2014) calling for the creation of an organization similar to the Intergovernmental Panel on Climate Change (IPCC) to marshal evidence and catalyse policy across governments and stakeholders....an intergovernmental panel on antimicrobial resistance (IPAMR)” (Woolhouse & Farrar, 2014). But in the case of climate change, since 1988 global emissions have continued to rise, some still publicly question the reality of climate change, and questions have even been asked about whether the incremental increases in top-line certainty in IPCC reports, concerning global warming trends and their human causation, are worth the years of effort of thousands of volunteer scientists. It is therefore important to reflect on this history and draw lessons from it, both for the IPCC and for science advisory processes with similar ambitions.

The key lessons of the IPCC story are perhaps that there are a number of trade-offs which will need to be considered in designing similar institutions and processes of scientific assessment and advice. Here, we highlight three:

i) *global vs local*: between scientific knowledge that speaks of abstract global systems, to a global audience, and knowledge that pertains more closely to the local settings where the drivers and impacts of global change are more directly experienced. This dynamic plays out differently across the IPCC’s Working Groups, and reflects global distributions of expertise and knowledge which the IPCC cannot itself do much to change. However, regionally-focused assessments have been touted as a means of integrating more sub-global information and local relevance into the IPCC process.

ii) *scientific disinterestedness vs policy relevance*: between processes which aim to stay firmly on the science side of the science-politics boundary, sticking to the norm of scientific disinterestedness, and processes which engage more directly with value-laden policy questions. The former strategy may help enhance the scientific authority of a process, but perhaps at the cost of direct policy relevance. The IPCC has long guarded the norm of ‘policy relevant, never policy prescriptive’, but some have argued that steering clear from values-based questions has led to a lack of real-world utility for IPCC reports, particularly when it comes to questions of adaptation and mitigation, where ‘is’ and ‘ought’ cannot be so easily separated.

iii) consensus vs conflict: a related trade-off concerns consensus and unitary statements versus the representation of conflicting views. Again, consensus may help enhance scientific authority, and please those policy-makers who value non-ambiguous statements (Mahony, 2013). But as shown above, the pursuit of consensus can lead to important omissions, either of uncertain findings, or of conflict and disagreement. Social science research has shown that the assumption that decision-makers only value unanimity and certainty is wrong (Stirling, 2010). Mediating between conflicting opinions and handling uncertainty is the bread and butter of politics; and scientific advisory processes may benefit from acknowledging points of disagreement

From this it appears that if we are to have an Intergovernmental Panel for Antimicrobial Resistance, or any other global challenges for that matter, the IPCC model cannot be treated as being easily transferable. Global (as opposed to national) science advice involves different design and problem framing choices that should be openly considered by a range of actors, and at the earliest available opportunity. As we have illustrated through the three trade-offs above, there are no perfect solutions when providing policy-relevant science advice on a global level. However, being aware of the underlying and ongoing issues that have surfaced during the IPCC's history provides a sound platform for decision-making and future learning.

QUESTIONS FOR REFLECTION

- Do we need to disaggregate the IPCC's global focus into more regionally-oriented assessment modes? Has the IPCC 'finished the job' when it comes to reporting on the headline global trends, and do policy-maker information needs now lie elsewhere?
- To what extent should the IPCC assessment process be opened up to more diverse forms of knowledge – whether from the social sciences and humanities, or what's commonly referred to as 'local' knowledge, perhaps that of key stakeholders, indigenous groups, or those already suffering the effects of climatic extremes?
- To what extent does the IPCC provide an institutional blueprint for scientific assessment and advisory processes in complex issues domains? What issues might arise when attempting to transfer the IPCC model into other areas of science advice?
- Would assessment reports less focused on finding consensus be of greater public value? Would such reports be well-received by policymakers?

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PHOTO CREDITS

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In Pursuit of Solid Ground

Understanding the evidence on shale gas extraction in Canada



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ASSESSING **EVIDENCE**
INFORMING **DECISIONS**

THE ISSUE (as of 2014)

As global population and income growth increase the demand for all sources of energy, including fossil fuels, climate change is creating demand for cleaner energy sources. Shale gas - a potentially inexpensive source of energy that could reduce greenhouse gas emissions - may hold promise of easing these opposing predicaments. Over the past few decades, technological advances have made shale gas extraction economically viable, increasing global interest in its development. However, there is ongoing concern about the nature and extent of the environmental impacts of shale gas development, including local and regional impacts on water, land, air and communities. Policies for shale gas development are being debated in a number of countries including the United Kingdom, United States, France, and Australia.

THE SCENARIO

You have been asked to provide evidence to inform your Minister of Environment's long-term policy on shale gas development. You are aware of a recent evidence-informed assessment undertaken by a panel of experts in Canada on this very issue, which you can use to inform your advice to the Minister. Your briefing should include the following considerations:



Who are the stakeholders that would be affected by shale gas development?



What is the state of the evidence to inform recommendations?



Do the mitigation options identified adequately reduce the potential environmental impacts?



Should Canada consider developing shale gas as a bridge toward a low-carbon economy?

THE CASE STUDY

To inform discussion of the scenario questions, the following background information on shale gas and its development in Canada is provided. The information, including figures, is from a 2014 expert panel assessment by the Council of Canadian Academies (CCA) that was carried out at the request of Canada's federal government. The CCA tasked a multidisciplinary and multi-sectoral expert panel with the following question: What is the state of knowledge of potential environmental impacts from the exploration, extraction, and development of Canada's shale gas resources, and what is the state of knowledge of associated mitigation options?

¹ Council of Canadian Academies, 2014. Environmental Impacts of Shale Gas Extraction in Canada. Ottawa (ON): The Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction, Council of Canadian Academies.

1 Shale Gas Extraction in Canada

Large scale commercial shale gas production was first made possible in the late 1990s when two technologies - horizontal drilling and hydraulic fracturing – were combined and adapted to fracture a larger volume of sedimentary rock deep underground. The innovation opened the door to widespread extraction of shale resources, beginning in the United States in the 1990s and in Canada in the early 2000s.

With natural gas meeting over 30% of Canada's energy needs, and with conventional reserves declining in Canada, shale gas offers the prospect of significant increases in production. In 2014 Canada was producing about 4 cubic feet per day (Bcf/d) compared to 35 billion Bcf/d in the United States.

Although shale gas development in Canada has been concentrated in British Columbia and, to a lesser extent, Alberta, shale gas resources are also known to exist in Quebec, New Brunswick, Newfoundland and Labrador, and Nova Scotia, and likely in other regions as well. Extraction could provide opportunities for regions that have minimal experience with energy development. Sizable reserves exist on or near areas of Indigenous territories, as well as near rural communities.



Reproduced with permission from U.S. Energy Information Administration (EIA), 2011

Shale Plays (Oil and Gas) in North America

Known shale oil and gas plays in North America. Canada's largest reserves are located in British Columbia and Alberta, with smaller known deposits in Quebec, New Brunswick, Nova Scotia, and the territories.

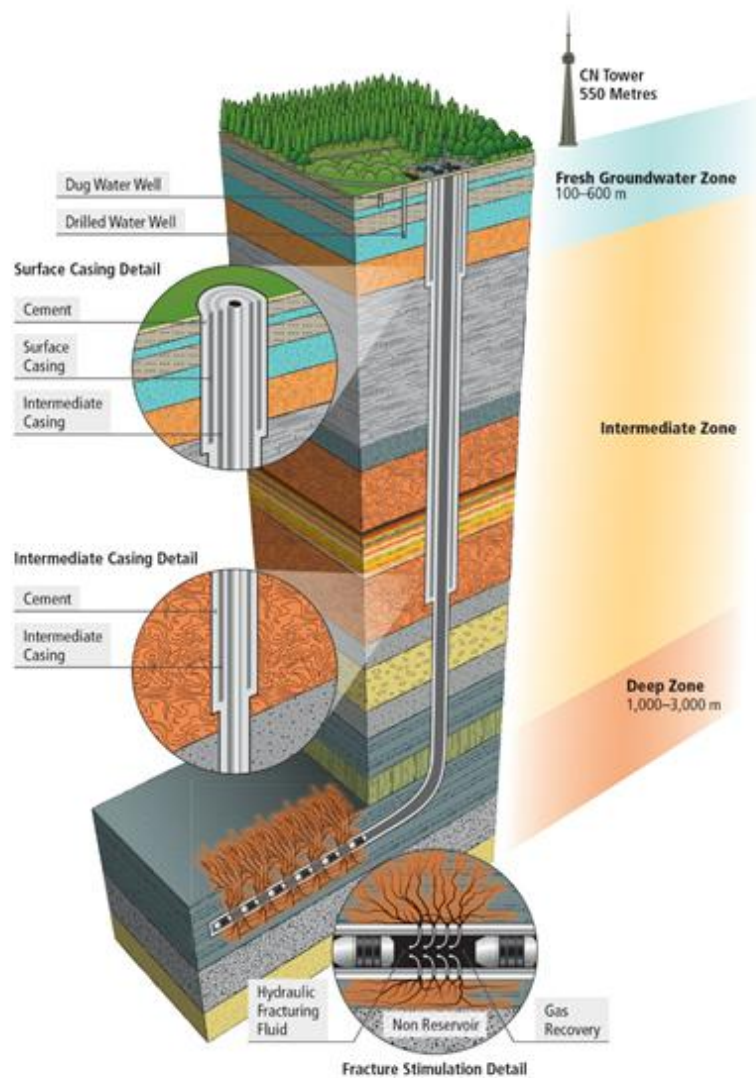
2 <http://www.eia.gov/todayinenergy/detail.php?id=19991>

What is shale gas?

Shale gas is a natural gas (mostly methane) that is tightly locked within low permeability sedimentary rock. Though the location of many shale gas resources has been known for a long time, only since the 1990s have technological advances made them accessible and their recovery economically viable.

Shale gas extraction requires the combination of brute force and sophisticated technology. The well itself comprises vertical shaft of a depth of 1.5 to 4 km, at the end of which is horizontal section drilled through the shale. Extraction occurs by injecting a mix of fluids, chemicals, and proppants (typically sand) into the well at extremely high pressure to fracture the target rock, and in the process increase the permeability of the shale. This process, called hydraulic fracturing, or fracking, enables the trapped gas to be released and flow to the wellbore.

Shale gas development requires: large amounts of water, chemicals, and proppants for hydraulic fracturing; land for well pads and ancillary facilities; energy to power the drill rigs, pumps, and trucks; and supporting infrastructure to gain access to the sites and extract and deliver the gas.



Adapted with permission from Apache Canada Ltd.

Well Construction Diagram for a Shale Gas Well

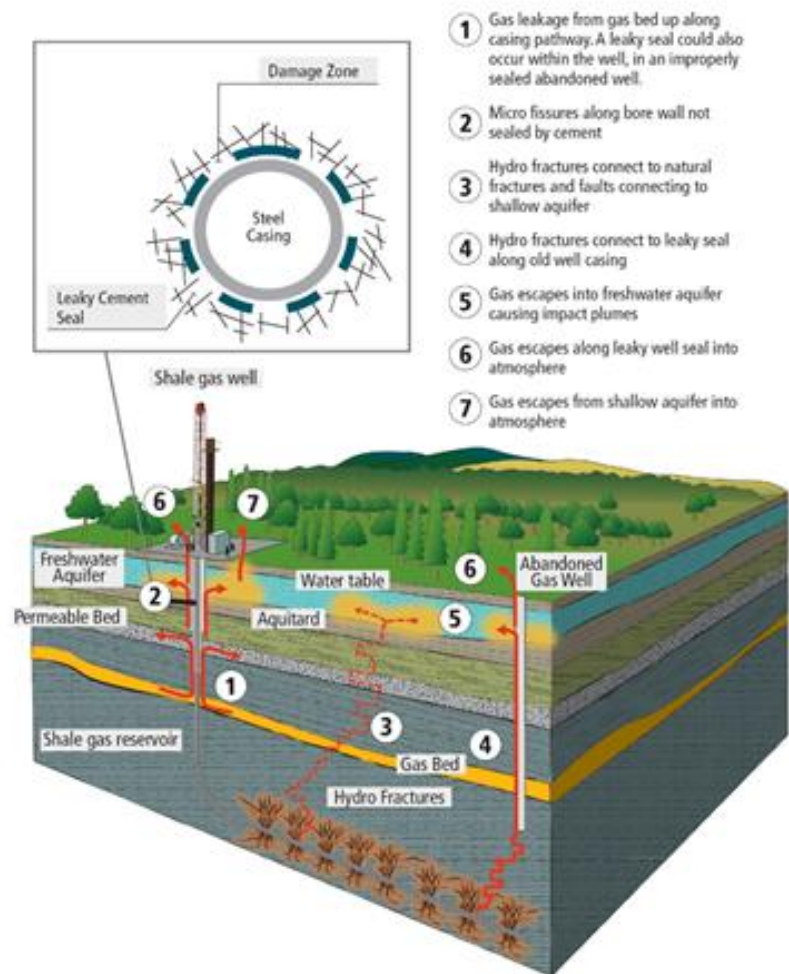
Schematic of a shale gas well, illustrating the various geological layers through which a well is drilled and the relative depth at which hydraulic fracturing occurs. Some laterals (the horizontal part of the well) are much longer than shown in this diagram and can reach up to 3 kilometres. The first two insets show the various casings (the steel tubing) that are inserted into the well and cemented into place. The bottom inset highlights a stage, a section of pipe between two packers that has been perforated in order to inject the hydraulic fluid to fracture the shale.

2 Environmental Impacts of Shale Gas Extraction

The Panel focused on four main categories of impacts – water, air emissions, land, and human health – stemming from the extraction of shale gas and related infrastructure. Of particular concern are water contamination and gas emissions, both of which are related to well integrity (i.e. the degree to which wells are sealed, which prevents leakage). The Panel was challenged by the rapidly evolving information and were cautious in assessing impacts far into the future based on minimal and continually changing evidence. Indeed, a central challenge for the panel was the fact that the main long-term impacts of shale gas development will only become evident after the passage of decades or longer, a challenge that was compounded by the lack of baseline measurements for current shale gas developments.

2.1 Water

The impact of shale gas development and production on water was recognized by the Panel as the most significant environmental concern. Groundwater can be affected by gas leakage from wells, and from the accidental surface releases of fracturing chemicals and wastewater (including from wastewater ponds), which may also affect surface water resources. In addition, hydraulic fracturing, by injecting water and fracking chemicals in large quantities deep into the ground, results in large quantities of polluted wastewater which can include naturally occurring radioactive materials. Disposing of this wastewater economically and safely is a major challenge, as cleaning it can be complicated and expensive. The optimum method for disposal is to inject wastewater deep into the geological formation. This method is used in British Columbia but is not possible in all shale gas-containing regions of Canada because of the geological conditions.



Courtesy of G360 Centre for Applied Groundwater Research, University of Guelph

Conceptual Groundwater Contamination Pathways

There are several pathways by which potable groundwater could become contaminated by shale gas development, as shown in the schematic above. Note that this schematic is not to scale and does not imply that any of these pathways are necessarily present at any given site. The pathway marked by a dashed line is hypothetical as there is no known case of migration of hydraulic fracturing fluids from the deep shale zone to the groundwater level directly through the overburden rock.

The timing of water withdrawal is also a particular concern for some regions where there are several competing uses for freshwater (e.g., agriculture, the environment, communities). Recent advancements, however, have led to a reduction in the freshwater needed for fracturing; for example, saline water is now an option for fracturing in some regions.

2.2 Greenhouse gas emissions

Shale gas is a fossil fuel whose production and use result in emissions of carbon dioxide and methane, both greenhouse gases (GHGs) that contribute to climate change. As a natural gas, it burns more cleanly than other fossil fuels, emitting about half the carbon dioxide than coal. Shale gas holds the promise of reducing global GHG emissions but only if natural gas extracted from shale replaces coal in electricity generation. If shale gas displaces low-carbon fuels, such as nuclear energy or renewables, including hydro-electricity, the potential GHG reduction benefits of shale gas disappear.

The overall reduction of GHG emissions is lessened by the leakage of methane, which has a stronger GHG effect than carbon dioxide. Methane can leak from shale gas production and transmission, as well as from abandoned wells, leakage from which can increase over time due to cement failure. There is also concern that an abundance of low cost methane gas from shale development could reduce incentives for investing in low carbon alternatives. The net impact of shale gas globally on GHG emissions will therefore depend on control of methane leakage and on broader energy and climate policies.

2.3 Land

Shale gas extraction has regional and cumulative effects that extend beyond the well or well pad. These may include deforestation and the disruption of ecosystems from fragmentation and edge effects due to access roads and well pad construction, and adverse effects on existing land uses, such as agriculture. With technological advances allowing for longer horizontal wells, more wells can now be placed on fewer pads, reducing the overall environmental footprint.



Courtesy of Hayley Dunning

Shale Gas Infrastructure in Northeastern British Columbia

An aerial view of landscape disturbance caused by shale gas development in northeastern British Columbia.

The process of injecting wastewater at high pressure is also associated with unintended seismic events. Most experts judge this risk to be low when injection is done in suitable geological formations; micro-seismic monitoring during operations, along with careful site selection and management, can further diminish this risk.

2.4 Human Health

Shale gas extraction is associated with a range of health risks stemming from waste products, air pollution, psychological impacts, and community disruption, though there are significant knowledge gaps in understanding these impacts. With regard to waste products, many of the waste chemicals (e.g., hydrocarbons, BTEX chemicals (benzene, toluene, ethylbenzene, and xylene), brine, arsenic) are associated with health impacts, though these chemicals are often used in very low concentrations. There are several potential pathways to exposure including leaks or spills that contaminate people via well water or the food chain. As for related air pollutants (e.g. particulate matter, nitrogen oxides, volatile organic compounds), these may lead to a small increase in the risk of cancer and other diseases such as neurological and respiratory effects for those living in close proximity.

Shale gas development can bring positive impacts to local communities, providing a stimulus to local economies arising from jobs for local residents, and customers for local businesses. However, these benefits may be offset by “boom-town” effects in regions that previously did not have oil and gas developments. Such negative impacts include a rise in income inequality, health and safety issues related to a large increase in truck traffic, and the difficulty in adapting local services to the influx of a transient workforce. Finally, impacts on psychological and social well-being have been linked to human health impacts (e.g., fatigue, headaches).

3 Mitigation Options

The shale gas industry has made progress in mitigating some environmental impacts. Through research and development, the industry has been able to reduce water use, land disruption, the volume and toxicity of chemicals used, and methane emissions.

Properly designed management strategies can support responsible shale gas development. The Panel identified aspects of an effective framework for managing the risks posed by shale gas development:



Equipment and products used must be designed in compliance with specifications, and tested and maintained for reliability.



Equipment and processes used to develop and operate shale gas sites must have comprehensive and rigorous safety management.



The development of shale gas must be based on science-driven and outcome-based regulations with strong performance monitoring, inspection, and enforcement.



Drilling and development plans must reflect local and regional environmental conditions, including existing land uses and environmental risks.



Environmental data should be transparent and available to all stakeholders. Public engagement should occur throughout development.

4 Policy Considerations

There has been much public concern in Canada about the environmental impacts of shale gas development. Moreover, these impacts differ by region and are influenced by such factors as population density, local water usage, regulation, Indigenous rights and titles, and whether the resources are situated on private land, as is common in the east, or on provincially owned lands as is typical in the west.



Insufficient data poses challenges for understanding impacts and risks

In most instances, shale gas development has proceeded without the collection of sufficient environmental baseline data. This makes it difficult to identify and characterize impacts, or to dismiss impacts that are perceived to be inappropriately associated with development. Past monitoring in Canada and elsewhere indicates that gas leakage into aquifers and the atmosphere is frequent enough to raise concern. Possible environmental and health effects of shale gas development may take decades to become apparent, underlining the need for long-term monitoring and adaptive management.



Contrasting views on shale gas development as a bridge to a low carbon economy

There are contrasting views on how shale gas development could affect GHG emissions. Proponents argue that shale gas will have a desirable impact on climate change because natural gas releases less carbon dioxide when burned than coal/oil; others maintain that methane leakage lessens these benefits and that further development of shale gas resources may increase consumption (due to cheap gas), negating the benefits, and reinforcing the patterns of fossil fuel dependency that drive climate change. Though clean energy is becoming increasingly cost competitive with traditional fossil fuels, they remain more expensive and require significant infrastructure investment. Furthermore, clean energy still face technological hurdles related to intermittency (e.g., when the sun doesn't shine or the wind doesn't blow), transmission, and storage. Some propose that natural gas could serve as a bridge – from coal and oil to renewables – if one expects cost reductions and technological advances in clean energy to be slow (say a decade or two away). Others raise concern that investing in shale gas as a bridge may delay development of renewable resources.



Challenge in balancing local, regional, provincial, and national concerns

Shale gas development poses challenges for governance. Its benefits are primarily regional or national, while many of the adverse impacts – on water, air quality, land - are local. Decisions on development also need to consider Indigenous rights and title issues, differences in social context, and the fact that many questions remain about environmental impacts for which there are no answers due to limited study or monitoring. Some provinces, which in Canada have jurisdiction over shale gas development and its regulation, are therefore engaged in a “go-slow” approach allowing time to collect and respond to new information.

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